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Volume 57 July, 1941 No. 1

A SYNOPSIS OF THE GENUS *MESOSTOMA* EHRENBERG 1835

By Frederick Ferdinand Ferguson and Wayland J. Hayes, Jr.

With 20 Text-Figures

INTRODUCTION

The early history of the genus *Mesostoma* contains the illustrious names of Müller (1776), Ehrenberg (1835), and Schultze (1851). In the more contemporary literature the work of Luther (1904) is outstanding. The epic work of Graff (1913) presents the historical development of the genus in a very complete manner. Modern studies include the excellent work of Hyman (1938–39), and that of Ruebush (1939) upon the highly differentiated Tibetan species. The contributions of Kepner (1938) and Husted (1939) with their associates are noteworthy additions to a literature which is becoming marked by careful, thorough research not only on the gross anatomy but also on the cytology and physio-cytology.

Present work, however, is handicapped by the inaccessibility of some of the literature and the consequent vagueness of the taxonomic boundaries of the genus. There has for some time been a need for a concentration of all the literature references, all the valid species descriptions, and finally for a designation of all the species as valid, invalid, or transferred. This task has been undertaken in the present paper.* We have attempted to make the bibliography as complete as possible. The

* The authors wish to express their thanks to Drs. Ladley Husted and T. K. Ruebush for their stimulating criticism of this paper. An award of the Research Committee of the Virginia Academy of Science has aided materially in the production of this work.

references to each species are presented chronologically; those of the bibliography are alphabetized. An effort has been made to list every species which ever bore the generic name and to record its present standing. The separation of the valid species of *Mesostoma* has been accomplished by a key which is more or less artificial but is based on taxonomic features accepted by modern workers. In forming the key we have been driven to the conclusion that some species long in good standing depend, in fact, for their differentiation on characters of such transitory nature that no modern author will use them for distinguishing new species. The authors see no reason why characters not definite enough to distinguish new species should be good enough to separate old ones. Therefore, we have placed some previously accepted species in *species dubiae*, believing that no further attention should be paid to them, unless animals collected from the type locality of the supposed species be given a complete redescription and be found to exhibit specific differences from the species here accepted. A list of the acceptable and unacceptable taxonomic criteria in the genus *Mesostoma* has been placed at the end of the section on anatomy in this paper.

This paper does not in any sense undertake a complete discussion of the genus; it does attempt a complete outline. The essential features of structure are discussed and reference is made to interesting and special studies on development, cytology, etc. In the diagnosis of species usually only those characters are mentioned which are of some classificatory value.

CLASSIFICATION

(Bresslau 1933)
Class: Turbellaria
Order: Rhabdocoela
Sub-Order: Lecithophora
Section: Typhloplanoidea
Family: Typhloplanidea
Sub-family: Mesostominae
Genus: *Mesostoma* Ehrenberg 1835

(Meixner 1939)
Class: Turbellaria
Order: Neorhabdocoela
Sub-Order: Typhloplanoida
Family: Typhloplanidae
Sub-family: Mesostominae
Genus: *Mesostoma* Ehrenberg 1835

GENUS DIAGNOSIS:—*Mesostoma* Ehrenberg 1835. Rhabdocoela with a rosulate pharynx attached to the ventral side of the enteron usually

slightly anterior to the middle of the body; without a distinct Russel-like organ although often with the anterior end capable of slight invagination and subsequent protrusion; without epidermal blind sac or ascus; with a single gonopore often combined with the mouth; with testes dorsal, usually medio-dorsal to the vitellaria; without vagina or ductus spermaticus; with bursa; with uteri paired and arising from the lateral or posterior surface of the genital atrium; without a connection between the reproductive organs and the enteron; with a pair of excretory stems opening into a common beaker combined with the mouth; eggs ectolecithal, usually of two sorts, the so called "winter" and "summer" eggs.

GENUS HISTORY

1776, *Planaria* (part.: *Planaria grossa*, *Planaria tetragona*), O. F. Müller in: Zool. Dan. Prodr., p. 221. / 1835, *Mesostoma* (part.: *Mesostoma grossum*), Ehrenberg in: Abh. Ak. Berlin, p. 244 (nota). / 1848, *Mesostomum* (part., excl.; *Mesostoma rostratum*, *Planaria personatum*) and *Schizostomum* (sp. un.: *Schizostomum productum*), O. Schmidt in: Rhabd. Strudelw. Süss. Wass., p. 40, 54. / 1882, *Mesostoma* (part.) L. Graff in Monogr. Turbell., v. 1, p. 285. / 1904, *Mesostoma*, Luther in: Z. wiss. Zool., v. 77, p. 145, 218. / 1909, *Mesostoma*, L. Graff in: Brauer, Süssw., v. 19, p. 118. / 1913, *Mesostoma*, L. Graff in: Das Tierreich, v. 35, p. 263–285. / 1933, *Mesostoma*, Bresslau in: Kükenthal und Krumbach "Handbuch der Zoologie". / 1939, *Mesostoma*, Meixner 1939.

DISTRIBUTION

Species of *Mesostoma* may be found in the fresh waters of Europe, Asia, and North America. Members of *Mesostoma lingua* are said to occur in European brackish waters as well as in fresh water. Representatives of *Mesostoma arctica* live in the fresh water pools of northern Manitoba, Canada (58° north latitude). Members of *Mesostoma ehrenbergii* are found in the fresh waters of Europe, Tomsk in Asia, and, it is said, North America and Trinidad. In opposition to this wide range of distribution some species, especially those recently described, are known only from restricted localities. Thus *Mesostoma virginiana* has yet been reported only from the fresh water swamps of Green County, Virginia, U. S. A. Ruebush has made an excellent study of three new Asiatic forms, *Mesostoma baoensis*, *Mesostoma togarmensis*, and *Mesostoma chusholensis*, from North India in the Tibetan area. Certainly no other *Mesostoma* and perhaps no other rhabdocoele has been collected at such an altitude (5200 m.) as *Mesostoma togarmensis*. It will be readily seen that species of *Mesostoma* possess a wide range of distribution both as

regards some individual species and as regards the genus. However, this distribution is not as universal as the literature on all the animals, which have at one time or another been given the name *Mesostoma*, might lead one to suppose.

ANATOMY

The size of the species of *Mesostoma* varies considerably. The American forms measure up to slightly over 5 mm., while the European forms may measure up to 15 mm. (*Mesostoma ehrenbergii*). This longest representative measures 4 mm. in width.

The shape of the worms varies from that of *Mesostoma ehrenbergii* (Fig. 1) with its elongate, anteriorly rounded and posteriorly pointed, spindle-like figure to the bulky body of *Mesostoma virginiana*. This latter animal has a somewhat oblanceolate contour with a broadly rounded posterior end. Further, the loose epidermis of *Mesostoma virginiana* forms extensive flaps or flanges along the sides of the body of the living animal. *Mesostoma ehrenbergii* does not possess these flaps.

LEGEND TO TEXT-FIGURES

ac = atrium copulatorium
al = anterior loop of protonephridia
bc = bursa copulatrix
br = brain
bs = blind sack
cs = cross stem
ct = cuticular part of penis
cvd = common vitello-duct
dc = ductus communis
e = eye
eg = egg
en = enteron
fc = flame cell
ga = genital atrium
gg = granule glands
gp = gonopore
iga = inferior genital atrium
k = nucleus
in = longitudinal nerve
m = mouth
mg = combined mouth and gonopore
ms = main stem
n = nerve
ne = nerve ending
od = oviduct
ov = ovary
p = penis
pg = pharyngeal glands
ph = pharynx
pn = protonephridium
pp = penis papilla
pv = protonephridial vesicle
rh = rhabdite
rk = retinula
rs = receptaculum seminis
sg = shell glands
stk = Stiftchenkappe
t = testis
ut = uterus
v = penis valve
vd = vas deferens
vdt = vitelloduct
vit = vitellaria
vg = vesicula granulorum
vs = vesicula seminalis
yf = yolk follicles

Body flaps, of course, result in a more or less angular cross section. It must be noted, however, that fixation and consequent contraction may

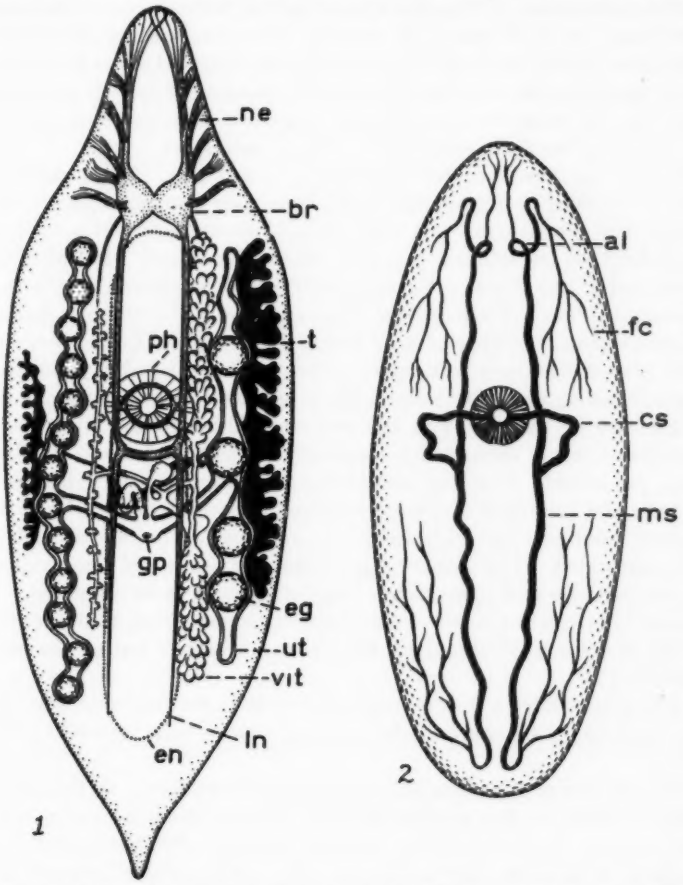


FIGURE 1. Dorsal view of gross anatomy of a *Mesostoma*. × ? After Graff, Vogt, Fuhrmann and Luther.

FIGURE 2. Dorsal view of protonephridial system of *Mesostoma ehrenbergi* (Focke). × ? After Leuckart 1852.

result in an angular cross section in animals which when living possess no flaps. This situation has been specially noted in the case of *Mesostoma arctica* by Hyman (1938). Doubtless this fixation reaction is

similar in many forms and the cross sectional contour of preserved material gives little hint of the true shape of the animal.

The movements of *Mesostoma* are confined either to a cumbersome swimming or to a creeping motion. The elephantine *Mesostoma virginiana* has not been seen to swim. When irritated some *Mesostoma* show quick flipping motions such as a fish might exhibit. This unusual phenomenon suggests a much higher degree of muscular and nervous development than is found in many other rhabdocoeles.

The color varies in shades of brown, gold and grey. The pigment is usually confined to the parenchyma but may also occur in the epidermal cells. The parenchyma may also contain oil droplets and a type of crystalloid is sometimes present. Some *Mesostoma* are colorless. Zoöchorellae are absent. Ruebush (1939) has commented on the fact that all the Tibetan species which he describes were collected from shallow water at great altitude and were deeply pigmented. He also observes that *Mesostoma lingua* in Europe is said to be more darkly pigmented when occurring in shallow water at great heights. *Mesostoma virginiana* might also be mentioned in this respect. Although the Blue Ridge mountains, where the animal is found, are not as high as those of Tibet, they do provide a strictly mountainous environment including cold water and a considerable diurnal variation in temperature. *Mesostoma arctica* found near the arctic circle in Canada at a very low altitude is also pigmented. The authors suggest that the relation of pigmentation to temperature and temperature variation should be investigated. It would be interesting to see if animals of the same strain would vary in shade of color if developed at different temperatures but at the same altitude.

The worms have a fine, even growth of cilia over the body, but lack modified ciliary structures such as spines, sensory hairs, or sensory hair tufts.

Paired eyes may be located somewhat dorso-posterior to the biganglionic "brain" or they may be lacking. In some (*Mesostoma virginiana*) the eyes are simple groups of pigment granules often connected by a median bridge. In others (Fig. 4) they possess those features, the ellipsoid, myoid, and rhabdoid, as delineated by Kepner and Stiff (1932) for *Macrostomum tuba*. While the eyes may appear black under low magnification, when enlarged they look reddish brown in most species or may even show a tinge of cherry-red (*Mesostoma rhynchotum*).

The central nervous system (Fig. 3) is composed of the bipartite "brain" and paired nerves. The "brain" gives off several pairs of

anterior nerves and two pairs of posterior-running, longitudinal nerve trunks. Of these trunks, the members of the more median pair are connected to a nerve ring in the pharynx and are further connected by a commissure just behind the pharynx. The more lateral pair of trunks lack commissures. The longitudinal trunks do not enlarge in the tail region as they do in some rhabdocoeles (*Macrostomum*). The anterior

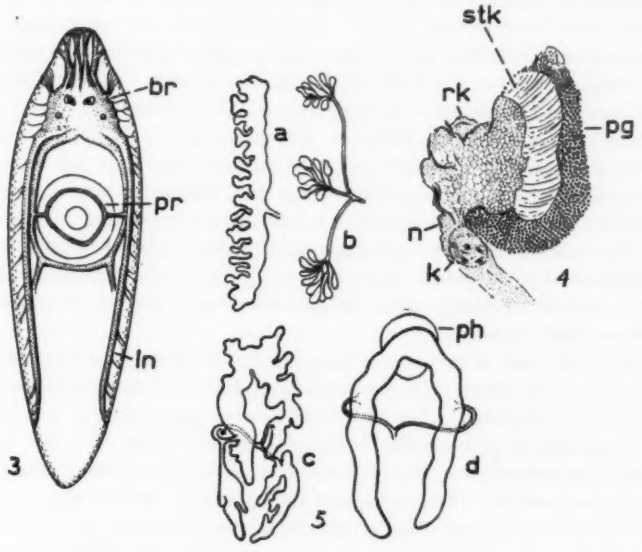


FIGURE 3. Dorsal view of nervous system of *Mesostoma lingua*. × ? After Luther 1904.

FIGURE 4. Section through the eye of *Mesostoma ehrenbergii* (Focke). × 960. After Luther 1904.

FIGURE 5. Diagrammatic representation of morphologic variation in the testes of *Mesostoma*. (a) *M. ehrenbergii*, (b) *M. tetragonum*, (c) *M. lingua*, (d) *M. craci*. × ? After Luther 1904.

rami are directed dorsally and ventrally in numerous strands which extend forward fan-wise to the tip and sides of the anterior end of the body. The rich nerve supply is correlated with the occurrence of various sense organs, a sensory snout, an anterior pit formed by epidermal invagination, or small pit-like sensory areas (Grubchenflecke) located antero-laterally, in different species.

The epidermal epithelium is a single-layered tissue composed of rather large polygonal cells 3 μ to 16 μ in height. Hyman states that the epidermis of *Mesostoma macropenis* is apparently syncytial. In mature animals a simple spheroidal nucleus lies near the center of each epithelial cell. In embryonic and therefore rapidly growing animals the nuclei of the epidermal cells are usually polymorphic.* The ciliary basal bodies have inwardly directed threads which produce a vertical striation in the outer layer of the plasma. The epithelium may be packed with short dermal rhabdites in its outer margin, or according to Hyman, in the basal portion of the cells of *Mesostoma arctica*. Rhammites may also occur sub-dermally over the general body surface and open to the exterior by short ducts through the epidermis. The erythrophilic, short (2 μ–18 μ) rhabdites are concentrated especially at the body extremities except at the points where the rhammite tracts open anteriorly. The elongate rhammites (sometimes exceeding 50 μ) show specific staining reactions and may either be distributed over the body or concentrated in anterior tracts or both. Numerous unicellular slime glands are located just under the muscular tunic and empty upon the external body surface.

The body wall is composed of an epidermis and two layers of non-striated muscle fibers. In the outer layer the elongate muscle cells are transversely disposed, whereas the cells of the inner layer lie parallel to the longitudinal axis of the body. These layers are usually, if not always, separated from the epidermis by a basal membrane sometimes of granular nature. The animals of this group are usually well provided with dorso-ventral and oblique muscles, especially in the anterior region where these muscles aid those of the body wall in controlling the mobile and often more or less protrusible anterior tip.

The parenchyma is of the type usually found in the Typhloplanidae.

The alimentary canal is simple and typical of that of the Lecithophora. The rosulate pharynx, lying usually just a little in front of the middle of the body, is well supplied with circular fibers and slender pyriform gland cells. The blindly ending enteron is composed of a very plastic, glandose epithelium. Numerous "Kornerkolben" are present. The system of tangential muscle threads mentioned above form a sort of basket work about the enteron. Digestion has been observed to be intracellular as well as extracellular.

The excretory system (Fig. 2) ably described by Leuckhart (1852) for *Mesostoma ehrenbergii*, appears to be of similar structure in the other

* Author's observation.

forms. Strongly developed, paired end stems empty laterally into the excretory beaker which opens through the mouth and constitutes a dilation of the pharyngeal pocket. The end stem is given off on each side near the middle of one of the pair of well developed, lateral branches. The pair of lateral branches extends for most of the body length, the ends breaking up into numerous smaller collecting branches which may closely embrace the gonads and yolk follicles and which bear at their tips flame cells.

The species of *Mesostoma* are hermaphroditic. Both genital systems communicate with the exterior through a common genital pore by way of a common genital atrium which may or may not be divided into superior and inferior genital atria. The mouth may, or may not, be combined with the common genital pore. Ruebush (1939) has observed that in young *Mesostoma chusholensis* the mouth and gonopore are clearly separate while in well matured animals the two openings enter a common chamber or depression on the body surface. Ruebush points out that this change is probably due to the growth of the copulatory organ and bursa which results in the forward inclination of the pharynx and the backward inclination of the genital complex. These displacements lead to the pulling up of the body wall between the two pores and consequently to the formation of a common chamber into which the mouth and gonopore open.

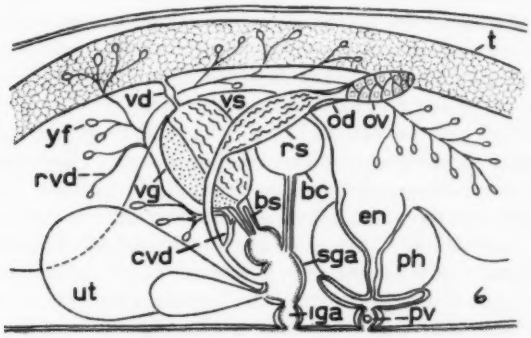
The male gonads (Fig. 5) consist of follicular or compact testes. These testes are always basicly paired as shown by the constant occurrence of paired vasa deferentia. In most species the testes of the two sides are themselves entirely separate. However, some species have the testes of the two sides anastomosing. This tendency reaches its highest development in *Mesostoma virginiana* where only small foramina remain between the fused, compact parts. The testes are essentially dorsal to the vitellaria, often being also more median than the vitellaria. Vasa deferentia, which communicate with a system of vasa eferentia, especially in the case of follicular testes, originate at about the mid-level of the testes and unite usually to produce a thin-walled ductus seminalis. This duct empties into the vesicula seminalis. The vasa deferentia may, however, empty separately into the vesicula seminalis. This spherical, muscular-walled organ is usually included in the tunic of the penis bulb which also houses the vesicula granulorum, yet in some forms described by Hyman the sperm sac occurs outside the bulb of the penis. The granule sac may be disposed dorsally or ventrally to the seminal vesicle within the bulbus. The bulbar male organ may have strong

walls composed of a thin outer layer of longitudinal muscles, two heavy layers of diagonal muscles, and a heavy inner layer of circular muscles (*Mesostoma togarmensis*). It may, however, lack this inner layer of circular muscle (*Mesostoma chusholensis*). The ductus ejaculatorius may also present a high degree of differentiation; Ruebush (1939, p. 59) states: "A cross-section of the ductus ejaculatorius shows an outer layer of circular muscles, a thick middle region which Luther (1904) has called 'epitheliales Plasma' and an inner, strongly cuticularized tube." This cuticular ductus may measure up to 280 μ in length (*Mesostoma togarmensis*). A small but none the less conspicuous blind sac is housed by the penis papilla or stalk in *Mesostoma virginiana*. The papilla in some forms lies in a well defined atrium copulatorium which is a dorsal dilation of the superior part of the genital atrium.

Mature sperm cells which may be found in the vasa deferentia, in the dilation of the ductus seminalis ("false vesicula seminalis"), or in the vesicula seminalis are elongate thin threads. They measure up to 230 μ (*Mesostoma lingua*) and possess, at least in the forms carefully studied in this respect, paired setae.

The organs composing the female reproductive system (Fig. 6) are more uniform in their morphology than are those of the male system. The ovary is a small, anteriorly directed, club-shaped gonad consisting of small lenticular oögonia and at times, larger and more distal oöcytes. In *Mesostoma virginiana* some interesting correlations between the respective conditions of the ovary and certain epithelia have been observed. The ovary may present two physiological phases. At times there are only lens-shaped oögonia; at other times a large oöcyte is to be found at the mouth of the oviduct. Associated with these ovarian phases are certain changes in the cells of the oviduct and in the epithelial cells of the receptaculum seminis. When the ovary contains only oögonia the oviduct epithelium is composed of slender, tall cells whose nuclei are club-shaped. On the other hand, when an oöcyte is present in the ovary, the epithelium of the oviduct becomes stout, its cells becoming quite as wide as high and apparently forming a syncytium while the nuclei become greatly enlarged. When the ovary contains only oögonia, the cells covering the outside of the receptaculum seminis and covering the muscles of that organ are flattened so that they form a heavy permanent layer. In comparison, when an oöcyte lies within the ovary, these peritoneum-like cells become altered so that instead of being flattened, they are stout and columnar. Morphologically the oviduct is short, slender, and rather thick-walled. The receptaculum seminis may be a simple dilated portion of the female

tract or, more rarely, it may be a discrete thin-walled sac appended to the tract near the oviduct.



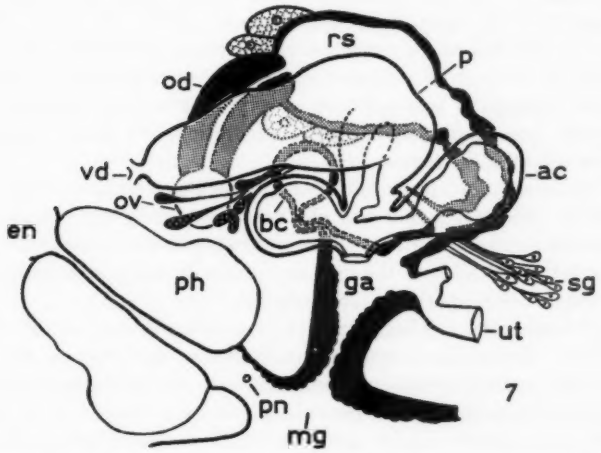


FIGURE 6. Diagrammatic lateral optical section of sex apparatus of *Mesostoma virginiana*. K., F., and S. × 33. After Kepner, Ferguson and Stirewalt 1938.
FIGURE 7. Diagrammatic left lateral optical section of sex apparatus of *Mesostoma arctica* Hyman. × ? After Hyman 1938.

The paired uteri may have a single uterine pore opening into the basal part of the common genital atrium, or they may empty separately. They may extend latero-posteriorly and thus exist only behind the

gonopore, or they may have a ⊦-shaped configuration and thus lie both anterior and posterior to the gonopore. It seems that, in those species where the uteri are posterior, the uterine wall is thin; while in those species where the uteri are ⊦-shaped, the uterine wall is thicker.

Eggs are of two types; there are small, thin-shelled, yolk-poor summer eggs and larger, hard-shelled, yolk-laden winter eggs. The former, it is said, may be self fertilized during the early development of those animals which are the first to hatch from winter eggs in early spring. The summer eggs develop within about 12 days. Embryos of good size have been observed to reach freedom by passing through the uterine wall, into the parenchyma, and out through the body wall of the mother. Undoubtedly this is an abnormal method of escape for the young animal. Winter eggs are liberated via the gonopore or, more usually, in great numbers when the animal dies. It is not known whether the animal may overwinter under natural conditions in a not too rigorous climate. It is sure that where conditions are unfavorable, the animals overwinter in the hard-shelled resting egg stage. It is also known that these same species may, under carefully regulated laboratory conditions, be made to live through many generations over a period of at least two years without the production of winter eggs and the consequent interpolation of a resting stage. Bresslau (1903 and 1904) has made noteworthy contributions to the cytology and embryology of these forms.

Vitellaria may be either follicular or papillose and are usually quite extensive. There is a union of all the vitello-ducts into a single main duct which enters the ductus communis below the receptaculum seminis and near the entrance of the ductus communis into the genital atrium when the latter is spatially differentiated.

The female accessory organ, the bursa copulatrix, has a most variable structure. It may be merely a thin-walled evagination of the dorsal wall of the genital atrium. It may be more complex, being provided with a thin-walled, highly distensible, slightly muscular, sac-like portion joined by a narrow, highly muscular stalk to the dorsal wall of the genital atrium. This complicated structure may, or may not, possess a cuticular lining. The stalk may be long or short and may be supplied with sphincters which surpass in strength the already strong circular muscles which constitute the walls of the stalk.

The common genital atrium may be subdivided into superior and inferior atria (Fig. 6) separated by a sphincter. The dorsal portion of the atrium may have short lateral diverticula. A space, within which

the penis papilla lies and is more or less definitely cut off from the rest of the atrium, is sometimes designated the atrium copulatorium. There is some degree of variance in the points at which the ducts and tracts of the two systems enter the atrium in the different forms. The bursa copulatrix opens dorsally into the atrium. The copulatory organ and the ductus communis open into the upper portion of the atrium, but either may be the more dorsal; the difference being correlated, it seems, with the development of the atrium copulatorium. Probably the most striking difference in the point of entrance occurs in the uteri of different species. The uteri may enter by a common pore or paired pores. In *Mesostoma virginiana* the uteri enter the lower portion of the superior atrium while in *Mesostoma baoensis* the uteri enter the inferior atrium. In all species the point of entrance of the uteri is more ventral than are the other openings into the atrium.

Because some of the species of *Mesostoma* have unusually long chromosomes that exhibit interesting non-association phenomena and because all the species which have been studied in this respect have easily observable chromosomes, the genus presents excellent cytological material. Reference is made to the valuable works of Husted (1939), Husted and Ruebush (1940) and Valkanov (1938) upon chromosome morphology in *Mesostoma*. We note with regret that this latter comprehensive work has not as yet been translated into an acceptable language. The following authors have made studies upon these chromosomes: Ruebush (1939) on *Mesostoma chusholensis*, 2N = 8, N = 4; Schneider (1883) on *Mesostoma ehrenbergii*, 2N = *ca.* 7; Bresslau (1904) on *Mesostoma ehrenbergii*, 2N = 10, N = 5; Luther (1904) on *Mesostoma ehrenbergii*, N = 5; Voss (1914) on *Mesostoma ehrenbergii*, 2N = 10, N = 5; Husted, Ferguson, and Stirewalt (1939) on *Mesostoma ehrenbergii* var. *wardii*, 2N = 8, N = 4; Luther (1904) on *Mesostoma lingua*, N = 3; Valkanow (1938) on *Mesostoma rhynchotum*, 2 N = 16, N = 8; Ruebush (1939) on *Mesostoma baoensis*, 2N = 8, N = 4; on *Mesostoma togarmensis* 2N = 8, N = 4; Kepner, Ferguson and Stirewalt (1938) on *Mesostoma virginiana*, 2N = 8, N = 4; Ruebush (1938) on *M.* sp. 2N = 6, N = 3.

Ruebush (1940) has indicated the desirability of using *Mesostoma ehrenbergii* var. *wardii* (collected in Genesee River between lower falls and Lake Ontario and sold by Ward Biological Supply Company, Rochester, New York) as the Turbellarian type in teaching. This large translucent form readily displays its anatomy, showing especially fine flame cells and chromosomes (up to 32 μ in length!).

TAXONOMIC CRITERIA

Anatomical features generally considered of classificatory value by modern workers include: the presence and form of the cuticular lining of the ductus ejaculatorius; the form of the penis itself, whether it be ovoid to pear-shaped, or retort-shaped, and the development of its muscular layers; the relationship of the vesicula seminalis and the vesicula granulorum; the nature of the testes whether definitely compact or follicular; the form, musculature, and lining of the bursa copulatrix; the form of the uteri; the configuration of the genital atrium, its size, division, and musculature, and the number and morphology of the chromosomes.

Recently Hyman (1938, p. 1, 2) and Ruebush (1939, p. 61, 62, 64) have mentioned those features of *Mesostoma* which must be used with great caution in taxonomic work. The reasonableness of these authors' statements is evident to anyone who has ever worked with *Mesostoma*. The highly variable features include: the shape of the body and its cross-sectional configuration; the development of the protrusible anterior tip of the body; the pigmentation; the presence or absence of eyes; the mouth gonopore relationship; and the size and degree of anastomosis of the testes.

KEY TO THE SPECIES OF MESOSTOMA

1 (18) Penis without cuticular lining of the ductus ejaculatorius..... 2
2 (5) Vesicula seminalis separated from the vesicula granulorum by a constriction..... 3
3 (4) Uteri extending posteriorly from the common genital atrium..... *M. macroprostatum*
4 (3) Uteri T-shaped..... *M. macropenis*
5 (2) Vesicula seminalis and vesicula granulorum distinct but both contained in the bulbus of the penis..... 6
6 (13) Uteri extending posteriorly from the common genital atrium, not T-shaped..... 7
7 (10) Atrium divided..... 8
8 (9) With an atrium copulatorium but without a division of the atrium into superior and inferior parts..... *M. canum*
9 (8) Without an atrium copulatorium but with the common genital atrium divided by a sphincter into an inferior part receiving the uteri and a superior part receiving all the other sex organs..... *M. baoensis*
10 (7) Atrium not divided in any way..... 11
11 (12) Without a cuticular lining of the common genital atrium..... *M. armeniacum*
12 (11) With the genital atrium covered by a cuticular membrane..... *M. platycephalum*
13 (6) Uteri T-shaped..... 14

14 (15) Testes with a small posterior and a large anterior anastomosing portion *M. lingua*
15 (14) Testes follicular or lobate, not anastomosing 16
16 (17) Chromosome number N = 5, 2N = 10 ..... *M. ehrenbergii*
17 (16) Chromosome number N = 4, 2N = 8 ..... *M. ehrenbergii wardii*
18 (1) Penis with a cuticular ductus ejaculatorius 19
19 (20) Vesicula seminalis separated from the vesicula granulorum by a constriction ..... *M. arctica*
20 (19) Vesicula seminalis and vesicula granulorum distinct but both contained within the bulbus of the penis 21
21 (44) Without a blind sac in the penis papilla 22
22 (23) Cuticular ductus ejaculatorius ending distally in a crown of fine points or spines ..... *M. nigrorostrum*
23 (22) Cuticular ductus ejaculatorius without spines, either a simple tube or a cuticular membrane covering both the inside and outside of the papilla 25
24 (27) Ductus ejaculatorius a thin cuticular membrane covering both the inside and outside of the penis papilla 25
25 (26) Uteri simple extending posteriorly ..... *M. punctatum*
26 (25) Uteri T-shaped ..... *M. chromobractrum*
27 (24) Ductus ejaculatorius a simple tube 28
28 (35) Cuticular ductus ejaculatorius less than 100 μ in length 29
29 (34) Bursa copulatrix without a cuticular lining 30
30 (33) Entire length of the ductus ejaculatorius with a cuticular lining 31
31 (32) Eyes present; bursa copulatrix without a well developed stem ..... *M. productum*
32 (31) Eyes lacking; bursa copulatrix with a well developed stem ..... *M. columbianum*
33 (30) Cuticle present only in the distal part of the ductus ejaculatorius ... *M. bologoviense*
34 (29) Bursa copulatrix with a cuticular lining ..... *M. rhynchotum*
35 (28) Cuticular ductus ejaculatorius promiment, more than 100 μ long 36
36 (43) Cuticular ductus ejaculatorius less than 200 μ long 37
37 (38) Uteri T-shaped ..... *M. tetragonum*
38 (37) Uteri simple, extending posteriorly 39
39 (40) Atrium copulatorium set off by a sphincter ..... *M. mutabile*
40 (39) Atrium copulatorium not developed 41
41 (42) Penis retort-shaped; the cuticular lining widened in entering the genital atrium ..... *M. craci*
42 (41) Penis pear-shaped; the cuticular lining of the ductus ejaculatorius gradually narrowed distally ..... *M. chusholensis*
43 (36) Cuticular ductus ejaculatorius over 200 μ long ..... *M. togarmensis*
44 (21) With a blind sac in the penis papilla ..... *M. virginiana*

SPECIES DIAGNOSIS TO VALID FORMS

Mesostoma arctica Hyman 1938, *Mesostoma arctica*, Hyman in: American Museum Novitates, No. 1005. / 1939, *Mesostoma arctica* Hyman in:

American Midland Naturalist, v. 21, p. 646, 647. / 1939, *Mesostoma arctica* Hyman in: American Midland Naturalist, v. 22, p. 630.

Body anteriorly blunt (Fig. 7) with deep terminal depression, the diameter of the body diminishing gradually from the anterior end to a slender tail; color greyish brown or brown; with rhabdites in the basal portion of the epidermal cells and with rhammites present in the epidermis and in anterior tracts; general form of excretory system typical; mouth and gonopore combined; testes follicular, extensive, dorsal; vesicula seminalis separated from the large vesicula granulorum by a constriction, the vesicula granulorum in turn distinct from a special terminal portion of the penis bulb which bears the penis papilla; penis papilla bearing a cuticular ductus ejaculatorius and projecting into the genital atrium; female genital system regular; paired uteri extending latero-posteriorly; bursa copulatrix with a narrow stalk; superior region of the genital atrium with a large diverticulum lying to each side of the penis papilla; body length up to 5 mm.; habitat: fresh water pools near Churchill, Manitoba, Canada; type: catalog no. 263, American Museum of Natural History.

M. armeniacum Plotnikow 1906, *M. a.*, Plotnikow in: Zool. Jahrb. Syst., v. 23, p. 396, pl. 22, f. 1, 2. / 1938, *M. a.*, Kepner, Ferguson, and Stirewalt in Zool. Anz., v. 121, p. 312. / 1939, *M. a.*, Ruebush in: Zool. Anz., v. 126, p. 65.

Body elongate, widest at the beginning of the second body third in the region of the copulatory organs; both ends of the body broadly rounded, the posterior end more gradually tapered than the anterior; black pigment granules present in the mesenchyme especially in front of the pharynx, between the eyes, and between the follicles of the vitellaria; black, half-moon-shaped eyes provided with lenses and placed equidistant between the pharynx and the anterior end; pharynx near the end of the first body third; gonopore surrounded by a ring of glands; testes small; vasa deferentia provided just behind the gonopore with "false vesicula seminalis;" vesicula seminalis pear-shaped, without a cuticular ductus ejaculatorius; receptaculum seminis a widening of the germ duct; vitellaria extensive, surrounding the enteron on all sides; chromosomes unknown; body length 1.2 mm.; habitat: Goktscha-Sea, Russia.

Mesostoma baoensis new name,* *Mesostoma lingula* sub-sp. *baoensis* Ruebush 1939, *M.l.b.*, Ruebush in: Zool. Anz., v. 126, 3/4, p. 53–57, 58–63, 65, 66, f. 2, 3.

* In the author's opinion this animal deserves the rank of species and is herein renamed *Mesostoma baoensis*.

Body bluntly rounded anteriorly (Fig. 8), widest in the pharyngeal region, tapering to a point posteriorly; pigment dark brown, parenchymal; eyes present; rhabdites present in cellular epidermis and

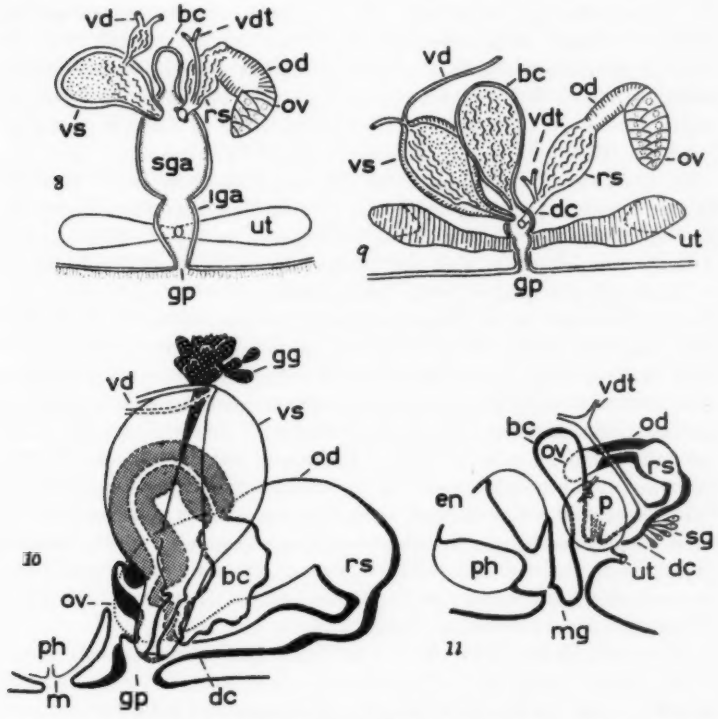


FIGURE 8. Diagrammatic anterior optical section of sex apparatus of *Mesostoma baoensis* (Ruebush) F. and H. × 133. After Ruebush 1939.

FIGURE 9. Diagrammatic anterior optical section of sex apparatus of *Mesostoma chusholensis* Ruebush. × 45. After Ruebush 1939.

FIGURE 10. Diagrammatic right lateral optical section of sex apparatus of *Mesostoma columbianum* Hyman. After Hyman 1939.

FIGURE 11. Diagrammatic left lateral optical section of sex apparatus of *Mesostoma craci*. O. Schmidt. × 47. After Luther 1904.

rhammiten in anterior tracts; excretory system undescribed; mouth and gonopore separate; testes large, dorsal, anastomosing anteriorly and posteriorly; penis bulb pyriform without an inner layer of circular

muscles, containing both the vesicula seminalis and the vesicula granulorum; ductus ejaculatorius short, not cuticular, superior and inferior divisions of the common genital atrium separated by a sphincter; bursa copulatrix a simple, short evagination of the dorsal wall of the superior genital atrium; female genital system regular; receptaculum seminis a dilated, thin-walled portion of the oviduct cut off from the superior genital atrium by a sphincter; paired uteri extending lateroposteriorly from their common opening into the inferior genital atrium; chromosomes: N = 4, 2N = 8; body length up to 2.5 mm.; habitat: pond near Bao in Western Tibet (elevation 4616 m.).

M. bologoviense Plotnikow 1900, *M. sp.*, Plotnikow in: Trudui St. Peterb. Obsch., v. 31–1, p. 341 (nr. 3). / 1906, *M. bologoviense*, Plotnikow in: Ber. Süsswassert. Naturf.-Ges. St. Petersb., v. 2, p. 3, 10, pl. 2, f. 3.

Body very elongate with the front end somewhat flattened; body colorless and transparent; long, thin rhammites present in the rodways; eyes with sharply set off black pigment cups sometimes connected by a loose pigment bridge; pharynx opening at the beginning of the second body third; gonopore opening at half the body length; testes elongate oval, posterior to the gonopore; vasa deferentia arising from the median surface of the anterior half of the testes, each vas with a small "false vesicula seminalis"; penis bulb pear-shaped, the ductus ejaculatorius short and tubular and provided in the distal half with a cuticular lining; bursa large and retort-shaped; receptaculum seminis spherical, cut off from the germ duct by a narrow stem; vitellaria small, smooth, reaching anteriorly to the region of the eyes; with at one time only a single concavo-convex egg present; chromosomes unknown; body length up to 1.5 mm.; habitat: Bologoje, Russia (Twer).

M. canum Weiss 1909, *M. c.*, A. Weiss in: Fauna SW. Australia. v. 2, p. 403. / 1910, *M. c.*, Weiss in: Z. wiss. Zool., v. 96, p. 337, 339, pl. 14, f. 3–6. / 1938, *M. c.*, Kepner, Ferguson and Stirewalt in: Zool. Anz., v. 121, p. 313. / 1939, *M. c.*, Ruebush in Zool. Anz., v. 126, p. 55.

Body of typical form known only from fixed specimens; brown pigment granules arranged in a reticulum in the mesenchyme especially dorsally; rhabdites, filling almost the entire height of the cells, abundant in the epidermis; peg-shaped or pestle-shaped rhammites present over the whole body and especially abundant along the sides and in the anterior rodways; mouth and gonopore combined, anterior to the body middle; oesophagus funnel-form; enteron sac-like, extending the entire body length; eyes small, black, and set close together, the length about 18 μ; testes dorsal, extending from the brain to the third body fourth,

similar in form to those of *M. ehrenbergii*; vasa deferentia opening separately into the upper part of the spherical vesicula seminalis which opens by a small papilla into the atrium copulatorium; female system typical, the receptaculum seminis a dilation of the germ duct, the germarium egg-shaped; bursa copulatrix round and strongly made, provided with a stem; vitellaria elongate, papillose, opening into the ductus communis opposite the shell glands; body length about 4 mm., width about 2 mm.; habitat: stream near Broom Hill, Southwest Australia.

M. chromobractrum M. Braun 1885, *M. c.*, M. Braun in: Arch. Dorpat. Ges., ser. 2, v. 10, p. 157, pl. 3, f. 18–20, pl. 4, f. 4. / 1902, *M. cyathus*, Dorner in: Schr. Ges. Konigsb., v. 43, p. 17, pl. 1, f. 2. / 1904, *M. chromobractrum*, Luther in: Z. wiss. Zool., v. 77, p. 227. / 1907, *M. c.*, L. Graff in: Brauer. Süssw., v. 19, p. 120, f. 227. / 1938, *M. c.*, Kepner, Ferguson and Stirewalt in: Zool. Anz., v. 121, p. 312.

Body of typical form, cross-section round in free swimming animals but quadrangular in contracted or fixed specimens; color brown as a result of pigment cells in the mesenchyme from which small, brown, 6 μ long pigment rods enter the epithelium filling every cell with from 30 to 90 pieces; long thread-like rhammites present in the anterior rodways as well as 3 to 7 in each epithelial cell of rest of the body; eyes close together, sometimes connected by a pigment bridge, nearer the anterior end than in *M. lingua;* pharynx pigmented, anterior to the body middle; excretory system typical; gonopore directly behind but separated from the mouth; testes large, follicular, dorsal, anastomosing for a short distance about the middle of the body, extending from the eyes to near the posterior end of the body; copulatory organ thin-walled, pear-shaped, slightly flattened on one side, receiving at the proximal end the vasa deferentia and more distally the granule glands; ductus ejaculatorius lined by cuticle which continues as a cuticular membrane over the end of the penis; copulatory organ and atrium provided with many pigment cells; bursa kidney-shaped, provided with a long muscular stem; vitellaria follicular; receptaculum seminis a distension of the germ duct; resting eggs concavo-convex or plano-convex, as much as 228 μ wide, brown in color, numbering in one instance 51 in a single animal; length up to 7 mm.; habitat: fresh water pools East Prussia and Livland.

Hofsten (1907, p. 459) considers this species identical with *M. lingua*, but the presence of a cuticular lining of the ductus ejaculatorius in the one and its absence in the other, as well as other differences, would seem to show that the two species are separate.

Mesostoma columbianum Hyman 1939, *Mesostoma columbianum*, Hyman in: American Midland Naturalist, v. 22, p. 629–636.

Body short, plump with rounded ends (Fig. 10), said to be dark grey; anterior end with a slightly pigmented, histologically set off area in each side thought to be sensory; cellular epithelium slightly and the ventral portion of the parenchyma more definitely pigmented; rhabdite tracts present as well as dermal rhabdites; eyes wanting; protonephridial opening typical; gonopore separate from mouth; testes follicular, dorsal; vesicula seminalis small, contained in the penis bulb, and displaced to the side by the highly developed, centrally placed granule channel; penis papilla with a cuticular ductus ejaculatorius; female system regular; vitellaria follicular, lateral bursa copulatrix with a muscular stalk cut off from the atrium by a sphincter; paired uteri extending latero-posteriorly; chromosomes unknown; body length 1.3 mm.; locality: pond, Chain Bridge, District of Columbia, U. S. A.

Mesostoma chusholensis Ruebush 1939, *Mesostoma chusholensis* Ruebush in: Zool. Anz., v. 126, 3/4, p. 60–64, 66, f. 6.

Body bluntly rounded anteriorly (Fig. 9), widest at the pharyngeal region, tapering to a point posteriorly; rhabdites present in cellular epithelium and rhammites in anterior tracts; eyes diffuse, closely set; excretory system unknown; mouth and gonopore separate though closely approaching one another in completely mature specimens; dorso-lateral testes anastomosing posteriorly only; penis bulb pyriform with a thin outer longitudinal, two median diagonal, and an inner circular layer of muscles; ductus ejaculatorius a cuticular tube (165 μ); female genital system regular; vitellaria with follicular anterior and posterior divisions; uteri extending latero-posteriorly from separate pores into the small undivided genital atrium; bursa copulatrix provided with a highly developed musculature and divided into a narrow stalk and a distensible sac; chromosomes: N = 4, 2N = 8; body length up to 3.2 mm.; habitat: pond near Chushol, south of Panggong Tso, Tibet.

M. craci O. Schmidt 1848, *M. tetragonum* (part.), O. Schmidt in: Rhabd. Strudelw. süss. Wass., p. 44. / 1858, *M. craci*, O. Schmidt in: Denk. Ak. Wien, v. 15, p. 27, pl. 2, f. 1–5. / 1862, *Turbella c.*, Diesing in: SB. Ak. Wien, v. 45–1, p. 221. / 1882, *Mesostomum c.*, + *M. tetragonum*, L. Graff, Monogr. Turbell., v. 1, p. 298; p. 295, pl. 4, f. 17–20, textf. 1. / 1885, *Mesostoma c.*, M. Braun in: Arch. Dorpat. Ges., ser. 2, v. 10, p. 164, pl. 1., f. 5; pl. 4, f. 1, 2. / 1890, *M. c.*, Böhmig in: Z. wiss. Zool., v. 51, p. 57, 71, 101, pl. 21, f. 13. / 1900, *M. sp.*, Sabussow in: Traudui Kazan Univ., v. 34-V, p. 24, 184. / 1902, *M. craci*, Dorner in:

Schr. Ges. Konigsb., v. 43, p. 19. / 1903, *M. oscari*, L. Graff. Turbell. Paras. Wirte, p. 57 (this is equivalent to *tetragonum* of Graff and not of Hallez). / 1904, *M. craci*, Luther in: Z. wiss. Zool., v. 77, p. 241, pl. 1, f. 33, 44; pl. 4, f. 19, 21; pl. 5, f. 34, 40; pl. 6, f. 3, 4, 13; textf. 9-H, 12. / 1904, *M. c.*, Markow in: Trudui Kharkov. Univ., v. 29, p. 39. / 1906, *M. craci*, Brinkmann in: Vid. Meddel., v. 58, p. 96, pl. 8. / 1909, *M. c.*, L. Graff in: Brauer, Süssw., v. 19, p. 123, f. 133H, 229. / 1911, *M. c.*, Meixner & Muth in: Rec. Ind. Mus., v. 6, p. 62, pl. 2. / 1939, *M. c.*, Ruebush in: Zool. Anz., v. 126, p. 49, 60 and 64.

Body elongate (Fig. 11), not more than one fifth as wide as long, pointed at both ends, the anterior end rounded in contracted animals; resting animals round in cross-section; swimming, contracted, or fixed animals quadrangular in cross-section; with the ventral side concave and a ring-shaped constriction at the body middle when suspended in water by a slime thread; mesenchyme colored by a brownish pigment; epithelial cells filled by rhabdites about 8 μ long, the cells at the anterior end of the body almost twice as high as those of the rest of the body; rhammites up to 48 μ long, concentrated in the anterior rodways; slime glands abundant on the ventral surface; eyes dark brown, elongate, placed close together, parallel to the mid-line, and sometimes anastomosing; mouth at or slightly behind the middle of the body, pharynx communicated to the enteron by a short eosophagus; gonopore opening into a slight depression behind the mouth; paired testes lying close together over the enteron and anastomosed over the pharynx to form a horse shoe shape; vasa deferentia arising dorso-laterally and uniting just before entering the vesicula seminalis; bulbus of the penis strongly muscled with one external layer of longitudinal muscle, two layers of oblique muscle, and an inner layer of circular muscle, the bulbus receiving somewhat to the side of the tip the united vasa deferentia and below that the granule glands; vesicula seminalis and vesicula granulorum lying beside one another within the penis bulb; ductus ejaculatorius lined by a cuticular tube about 166 μ long, funnel-shaped at the proximal end and provided with a sharp terminal enlargement distally; sperm thread-like with two flagella near one end; bursa retort-form, provided with a stem, placed anterior to the penis bulb; female system regular; receptaculum seminis a much swollen distension of the germ duct; vitellaria follicular, the follicles finger-like and almost always provided with stems; uteri simple, posteriorly directed sacs; winter eggs concavo-convex, thin-shelled, brick red or reddish brown in color, .52–.56 mm. broad, with as many as 20 found in a single animal; length

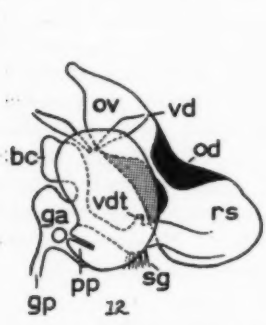
up to 12 mm. seldom over 15 mm.; habitat: same as *M. ehrenbergii* in Europe—Germany, Austria (from Krakau to Lesina), Russia (from Solowetzk to Kasan and Charkow)—reported by Meixner from Mangtsa Tibet about 4,800 m.

Mesostoma ehrenbergii (Focke) Schmidt 1848. / 1789, *Planaria tetragona* (part.), Abildgaard in: O. F. Müller, Zool. Dan., ed. 3, v. 3, p. 42, f. 106, f. 5 (Abbild.). / 1836, *Planaria ehrenbergii* (part.), W. Focke in: Ann. Wien. Mus., v. 1, II, p. 191, t. 17, f. 1–8, 11, 12, 15–19. / 1848, *Mesostomum ehrenbergii*, O. Schmidt in: Rhabd. Strudelw. süss. Wass., p. 47, t. 4, f. 9. / 1852, *Mesostomum ehrenbergii*, R. Leuckart in: Arch. Naturg., v. 181, p. 234, t. 9 (Anat.). / 1858, *Mesostomum ehrenbergii*, O. Schmidt in: Denk. Ak. Wien., v. 15, p. 32, t. 3, f. 3, 4. (Kopul.-Org.). / 1862, *Turbella ehrenbergii*, Diesing in: SB. Ak. Wien, v. 45, I, p. 220. / 1874, *Mesostomum ehrenbergii*, L. Graff. in: Z. wiss. Zool., v. 24, p. 146, t. 15, 16 (Anat.). / 1878, *Mesostomum ehrenbergii*, Metchnikoff in Zool. Anz., v. I, p. 387–390. / 1879, *Mesostomum ehrenbergii*, Hallez in: Trav. Wimereux Fasc. II. / 1883, *Mesostomum ehrenbergii*, Ant. Schneider in Das Ei, p. 17–21, 54–56, t. 3, f. 1–23 (Ei, Sperma). / 1885, *Mesostomum ehrenbergii*, C. Vogt (& Yung), Lehrb. vergl. Anat., v. 1, p. 247 (Anat., Histol.). / 1888, *Mesostoma ehrenbergii*, J. Kennel in Zool. Jahrb., v. 3, p. 447–486. / 1892, *Mesostoma ehrenbergii*, Ott, H. N. in: Journ. Morph., Vol. VII (3), pp. 263–304, pl. XIV, XVIII. / 1893, *Mesostoma ehrenbergii*, F. Wagner in: Biol. Centralbl., v. 13, p. 291–294. / 1894, *Mesostoma ehrenbergii*, Fuhrmann in: Rev. Suisse Zool., v. 2, p. 239, t. 10, t. 11 (Gehirn, Auge). / 1895, *Mesostoma ehrenbergii*, C. Wesenburg-Lund in: Vidensk. Medd. Naturhist. Foren. / 1895, *Mesostoma ehrenbergii*, A. Garbini in: Bull. Mus. Zool. Torino, V. 10, no. 198, p. 2, 6. / 1896, *Mesostoma wardii*, W. M. Woodworth in: Bull. Mus. Harvard, v. 29, p. 241, f. 2. / 1897, *Mesostoma wardii*, W. M. Woodworth in: Bull. Mus. Harvard, v. 30, p. 11, f. 6 (Abbild.). / 1903, *Mesostomum ehrenbergii*, Bresslau in: Verh. D. Zool. Ges., v. 13, p. 126, f. 1, 2 A (Eier). / 1904, *Mesostomum ehrenbergii*, Bresslau in: Z. wiss. Zool., v. 76, p. 220, 286 t., 14–16, tf. I, II (Entw.). / 1904, *Mesostoma ehrenbergii*, Luther in Z. wiss. Zool., v. 77, p. 227, t. 1, f. 1, 5, 9–11, 17, 18, 28–30; t. 2, f. 5, 7, 12–14, 16–25; t. 3, f. 9, 19–22, 25, 29; t. 4, f. 3–9, 17; t. 5, f. 3–11; t. 6, f. 12; tf 1, 9 D (Anat. Histol.). / 1904, *Mesostoma ehrenbergii*, Sekera in: Zool. Anz., v. 28, p. 233 (Biol.). / 1909, *Mesostomum ehrenbergii*, E. C., in Zool. Anz., Vol. 34, p. 257. / 1909, *Mesostoma ehrenbergii*, L. Graff in: Brauer, Süssw., v. 19, p. 121, f. 133 B., 201, 202, 228. / 1912, *Mesostoma ehrenbergii*, Hofsten in:

Rev. suisse de Zool., v. 20, Nos. 12 & 13. / 1913, *Mesostoma ehrenbergii*, L. Graff in: Das Tierreich, II. Rhabd. p. 273. / 1914, *Mesostoma ehrenbergii*, von Voss, H., in: Arch. f. Zellforsch., vol. 12, 159–194. / 1916, *Mesostoma ehrenbergii*, Ball, S. C., in: Journ. Morph., vol. 27, pp. 453–559. / 1918, *Mesostoma ehrenbergii*, Higley, R., in: Illinois Biol. Monogr., vol. 4, 195–288. / 1920, *Mesostoma ehrenbergii*, Harvey, E. B., in: Journ. Morph. and Physiol., vol. 34, 1–67. / 1933, *Mesostoma ehrenbergii*, Bresslau, E., in: Handbuch der Zool., II, pt. I, pp. 19–320. / 1935, *Mesostoma ehrenbergii*, Senn., H. A., in: Zool. Anz., vol. III, p. 47, 1935. / 1936, *Mesostoma ehrenbergii*, Phillips, H. M., in: Zool. Anz., vol. 114, p. 323. / 1936, *Mesostoma ehrenbergii*, Southern in: Proc. Roy. Irish Acad., V, XLIII, Sect. B., No. 5, pp. 56–57. / 1937 / 38, *Mesostoma ehrenbergii*, Valkanov in: Jarhb. Univ. Sofia V. 34. / 1938, *Mesostomum ehrenbergi*, Kepner, Ferguson and Stirewalt in: Zool. Anz., v. 121, 11 / 12, p. 307. / 1938, *Mesostoma ehrenbergii*, Ruebush in: Zool. Anz., v. 122, 11 / 12. / 1939, *Mesostoma ehrenbergii*, Ruebush in: Zool. Anz., v. 126, 3 / 4 / 1939, *Mesostoma ehrenbergii*, Husted, Ferguson, and Stirewalt in: Amer. Nat., v. LXXIII, pp. 180–185. / 1939, *Mesostoma ehrenbergii*, Hyman in: Amer. Midland Naturalist, v. 21, iii, p. 646, 50. / 1939, *Mesostoma ehrenbergii*, Hyman in: Amer. Midland Naturalist, v. 22, iii, p. 633. / 1940, *Mesostoma ehrenbergii* (Focke), Husted and Ruebush in: Jour. Morph., v. 67, no. 3, p. 387–410, f. 3–15.

Body very flattened (Fig. 12), about one third as wide as long, widest slightly behind the middle, the anterior end gradually narrowed and broadly pointed, the posterior end less gradually but more sharply pointed; body highly transparent, gradually assuming a brownish yellow mesenchyme pigment with advancing age especially in the region of the uteri and other sex organs and just under the body muscle layer; cilia of the anterior end 8 μ to 4 μ long, the cilia of the ventral side better developed than those of the back; rhabdites rod-form rounded at both ends, 3–4 μ long, present in all the epithelial cells, rhammites up to 60 μ long, slightly swollen at the free end, the swelling filled by an often granular material distinguishable from the cortex, the rhammites sparingly present over the whole body and abundantly in the anterior rodways; slime glands located in a strip along the whole ventral surface and especially at the ends; the slime cells at the posterior end pear-shaped, up to 64 μ long and connected to the body surface by ducts of similar length; eyes irregularly three-sided, placed equidistant between the mouth and the anterior end; sensory areas ciliated and specially in-

nervated, located on the anterior dorsal surface; excretory system typical; pharynx a little anterior to the body middle, leading by a typical oesophagus to the rod-shaped enteron; the latter about as wide as the pharynx, its anterior part extending almost to the brain, its posterior part ending some distance anterior to the posterior end of the body, but still nearly twice as long as the anterior part; gonopore posterior to the mouth and removed from it by a distance just greater than the diameter of the pharynx; testes lateral to the vitellaria and occupying roughly the middle third of the body length, each testis slightly irregular on the median side but deeply incised and follicular on the lateral aspect; vasa deferentia arising from the median surface



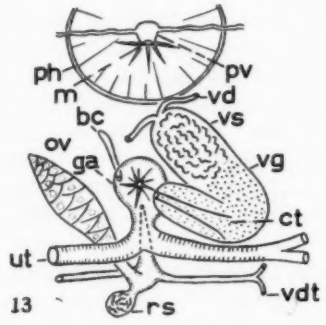


FIGURE 12. Diagrammatic left lateral optical section of sex apparatus of *Mesostoma ehrenbergii* (Focke). × 85. After Luther 1904.

FIGURE 13. Diagrammatic dorsal optical section of sex apparatus of *Mesostoma ehrenbergii* var. *wardi* Ruebush. × ? After Ruebush 1940.

of the testes and passing dorsally above the vitellaria to enter separately but close together into the vesicula seminalis; copulatory organ of retort-form with both ends directed posteriorly; ductus ejaculatorius a narrow tube, but with a characteristic diverticulum, lacking cuticle; the penis papilla extending somewhat into the atrium; on the anterior or anterio-lateral wall; sperm long and thread-like, provided with two flagella; female system typical; bursa an irregularly folded sac, the stalk especially provided with strong ring muscles, the bulb not strongly muscled; receptaculum seminis a spherical distension of the germ duct; vitellaria follicular, extending beside the enteron for nearly the length of the latter; uteri ⊦-shaped, opening, from the sides of the atrium, extending between the vitellaria and the testes and about the length

of the former or, during the production of summer eggs, even longer than the enteron; winter and summer eggs seldom formed in an animal at the same time; summer eggs spherical, 60–80 μ in diameter, thin-shelled, up to as many as 50 per animal; winter eggs lens-form when fully developed, dark brown, thick-shelled, 0.45–0.5 mm. in diameter, up to 31 per animal; chromosome number: N = 5, 2 N = 10; body length up to 15 mm., width 4 mm.; habitat: all Europe, including England, Sweden, Denmark, Holland, France, Switzerland, Austria, Hungary, and Russia; in Asia in Province of Tomsk; and perhaps in Island of Trinidad.

Mesostoma ehrenbergii wardii Ruebush 1940. / 1896, *M. Wardii* Woodworth in: Bull. Mich. Fish Comm., no. 6, p. 95. / 1896, *M. w.*, Woodworth in: Bull. Mus. Comp. Zool. at Harvard, v. 29, p. 241, f. 2. / 1897, *Mesostoma ehrenbergii*, Woodworth in: Bull. Mus. Comp. Zool. at Harvard Coll., v. 31, p. 1–16. / 1918, *M. e.*, Stringer in: Ward and Whipple, Freshwater Biology, p. 352, f. 625. / 1918, *M. e.*, Higley in: Illinois Biol. Monogr., v. 4, no. 3, p. 73. / 1938, *Mesostomum ehrenbergi*, Kepner, Ferguson, and Stirewalt in: Zool. Anz., v. 121, p. 307, 312. / 1939, *Mesostoma ehrenbergii*, Husted, Ferguson, and Stirewalt in: Amer. Nat., v. 73, p. 180–185, f. 1, 2. / 1939, *M. e.*, Hyman in: Amer. Midland Nat., v. 21, no. 3, p. 646. / 1939 b, *M. e.* (probably not equivalent to *M. wardii*), Hyman in: Amer. Midland Nat., v. 22, p. 633. / 1940, *M. e. wardii*, Ruebush in: Science, v. 91, p. 531–532, f. 1.

Body similar in form (Fig. 13) and transparency to *Mesostoma ehrenbergii ehrenbergii* and differing, in so far as is now known, only in the following characteristics: body cilia about 12.5 μ long; occasional bundles of sensory hairs about 35 μ long; male copulatory organ entering postero-lateral wall of genital atrium; ductus ejaculatorius short and without a diverticulum; false vesicula seminalis present or absent*; sperm cell about 1 μ thick and as much as 400 μ long, with two flagella about 53 μ long near one end; bursa copulatrix with strong muscles in the bulb as well as in the stem, the bulb compressed and not greatly in evidence; receptaculum seminis a spherical vesicle separated from the germ duct by a narrow opening; chromosome number: N = 4, 2N = 8; length up to 7 mm.; habitat: Illinois, Nebraska, Kansas, Michigan, New York, Ohio.

The difference in the chromosomes is the most striking and the most thoroughly studied. It may be that some of the habitats reported are

* Original observation.

incorrect, some other species having been mistaken by early workers for the present variety.

M. lingua (Abildgaard) O. Schmidt 1848. / 1789, *Planaria lingua*, Abildgaard in: O. F. Müller, Zool. Dan., ed. 3, v. 3, p. 40, t. 105, f. 7. / 1836, *P. ehrenbergii* (part), W. Focke in Ann. Wien. Mus., v. 1, ii, p. 202, t. 17, f. 13, 14. Wass., p. 40, t. 2, f. 6, 6c. / 1858, *Mesostoma cyathus*, O. Schmidt in: Denk. Ak. Wien, v. 15, p. 29, t. 2, f. 6, 7 (copulation organs). / 1862 *Turbella lingua* and *T. c.*, Diesing in: SB. Ak. Wien, v. 45, i, p. 220, 221. / *Mesostoma lingua*, F. A. Forel in: Bull Soc. vaud. Sci. Nat. Lausanne, v. 16, p. 313–327. / 1882, *M. l.* and *M. c.*, L. Graff in: Monogr. Turbell., v. 1, p. 288, t. 6, f. 1–4a, p. 289 (anatomy). / 1884, *M. l.*, Du Plessis in: Arch. Zool. exper., ser. 2, v. 2, p. 53. / 1885, *M. l.*, M. Braun in: Arch Dorpat. Ges., ser. v, 10, p. 157. / 1886, *M. l.*, Hallez in: CR. Ac. Sci., v. 102, p. 684. / 1886, *M. l.*, C. Vogt (and Yung) in: Lehrbuch vergl. Anat., v. 1, p. 281. / 1889, *M. l.* var. *cyathus*, Sekera in: SB. Bohm, Ges., 1888, p. 328. / 1894, *M. l.*, Hallez in: Cat. Turbell., ed. 2, p. 71. / 1894, *M. l.*, Fuhrmann in: Rev. Suissse Zool., v. 2, p. 238. / 1897, *M. l.*, C. A. Pugnat in: Rev. savoisienne. Annecy. / 1902, *M. l.* and *M. cyathus*, Dorner in: Schr. Ges., Konigsb., v. 43, p. 16, t. 1, f. 2. / 1903, *Mesostomum lingua*, Bresslau in: Verh. D. zool. Ges., v. 13, p. 126, f. 2, C (eggs). / 1904, *M. l.*, Bresslau in: Z. wiss. Zool., v. 76, p. 278, t. 19 (development). / 1904, *M. l.*, Markow in: Trudui Kharkov. Univ., v. 39, p. 34, t. 1, f. 13. / 1904, *M. l.*, Luther in: Z. wiss. Zool., v. 77, p. 222, t. 1, f. 15; t. 2, f. 8–10; t. 3, f. 5, 6, 8, 15, 24, 28; t. 5, f. 12–17, 33, 36; t. 6, f. 1, 2, 14, 15; textf. 2, 5, 9g, 11. / 1905, *M. sigmoideum*, Plotnikow in: Zool. Jahrb. Syst., v. 21, p. 481, t. 25, f. 1. 10. / 1906, *M. lingua*, Brinkmann in: Vid. Meddel., v. 58, p. 93, t. 4. f. 1–4. / 1907, *M. l.*, Hofsten in: Z. wiss. Zool., v. 85, p. 456, t. 23, f, 22, 23. / 1909, *M. l.*, L. Graff in: Brauer, Süssw., v. 19, p. 120, f. 133 g. / 1911, *M. l.*, Hofsten in: Zool. Bidr. Uppsala, v. 1, p. 73. / 1913, *M. l.*, L. Graff in Das Tierreich, v. 35, p. 268–271, f. 239, 240. / 1926, *M. l.*, N. Nassonov in: Bull. Akademiia Sci. URSS. / 1936, *M. l.*, Southern in: Proc. Roy. Irish Acad., v. XLIII, sec. B, no. 5, p. 56–57. / 1938, *M. l.*, Kepner, Ferguson, and Stirewalt in: Zool. Anz., v. 121, 11/12, p. 312. / 1939, *M. l.*, Ruebush in: Zool. Anz., v. 122, 11/12, p. 57, 63, 65. / 1939, *M. l.*, Husted, Ferguson, and Stirewalt in: Amer. Nat., v. 73, p. 184.

Body lancet-shaped (Fig. 14), anteriorly rounded and posteriorly stumped; with paired latero-anterior sensory areas; dirty gold color resulting from parenchymal pigment; rhabdites (4–8 μ) over the body

surface; rhammites (25–35 μ or even 51 μ) in anterior tracts as well as in the body generally; eyes close together, often anastomosing; excretory beaker and protonephridia regular; gonopore posterior to mouth; testes compact, with small posterior and large anterior portion, each portion giving off a vas efferentium which unites with the other of the same side to form the vas deferens of that side, the anterior portions of the testes anastomosing; sperm (280 μ long), with two setae; ductus seminalis rather long; penis simple with uncuticularized ductus ejaculatorius; penis papilla opening into atrium copulatorium, the left (sic) of a pair of diverticula of the undivided genital atrium; other diverticulum receiving all other sex organs except the penis; female genital tract regular; vitellaria ventral, follicular, and branched; uteri ⊢shaped

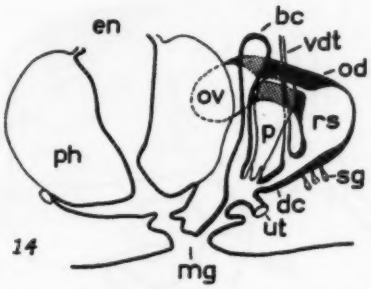


FIGURE 14. Diagrammatic left lateral optical section of sex apparatus of *Mesostoma lingua* (Abildgaard). × 135. After Luther 1904.

with a common opening into the genital atrium; bursa copulatrix pyriform with a narrow, muscular stalk; body length up to 9 mm.; habitat: fresh and brackish water of Sweden, Denmark, France, Germany, Switzerland, Austria, Russia, and Asia.

Graff (1913) rejects two varieties proposed by Hofsten (1907) but tacitly accepts the three varieties proposed by Brinkmann (1906) based chiefly on pigment, size, color, habitat, and egg production. These chiefly physiological differences might, it seems, form the basis for varietal differences. However, the authors feel that the three varieties of *Mesostoma lingua* (*M. l.* forma *typica*, *M. l.* var. *cyathus*, and *M. l. lacustris*) should be viewed with caution until it is shown that the eggs of one variety when placed in the habitat of another variety do not assume on maturity the form of the second variety.

M. macropenis Hyman 1939, *M. m.*, Hyman in: Amer. Midland Nat., v. 21, p. 646–650.

Body short (Fig. 15) fusiform, colorless except for mid-dorsal dark stripe; rhabdite tracts not noticeable; epidermis apparently syncytial, packed with small rhabdites and bearing a few rhammites; eyes evident only in living specimens; excretory system undescribed; gonopore slightly behind mouth; dorso-lateral testes, elongate, lobulate, without anastomosis; well developed ductus seminalis opening into a vesicula seminalis set off from the vesicula granulorum by a constriction and so

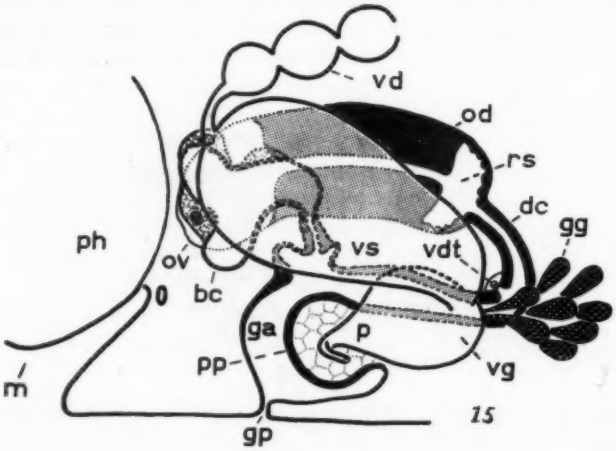


FIGURE 15. Diagrammatic left lateral optical section of sex apparatus of *Mesostoma macropenis* Hyman. × ? After Hyman 1939.

placed as to lie parallel to the latter; vesicula granulorum composed of a series of elongate chambers surrounding the central sperm duct and receiving proximally the long necks of the eosinophilic granule secreting glands; large, beak-like penis papilla continuous with the vesicula granulorum and bulging into the atrium, the uncuticularized ductus ejaculatorius asymmetrically placed; bursa copulatrix an irregular sac opening into the dorsal wall of the common genital atrium by a narrow muscular stalk; female system regular; vitellaria follicular; uteri ⊢-shaped; chromosomes unknown; body length 1,5 mm. or more; habitat: Douglas Lake, Michigan, U. S. A.

M. macroprostatum Hyman 1939, *M. m.*, in: Amer. Midland Nat., v. 22, iii, p. 629–636.

Body elongate (Fig. 16), dark brown, opaque, anteriorly narrowed, posteriorly rounded; pigmentation located not only in the parenchyma; but also in the cellular epithelium where it is concentrated ventrally; rhabdite tracts wanting; eyes elongate, dark; excretory opening typical; gonopore separate from mouth; testes undescribed;* vesicula seminalis small, rounded, set off by a constriction from the large, spindle-shaped vesicula granulorum which receives ventrally and proximally the eosinophilous secretion of the granule glands; penis papilla large, muscular, lacking a cuticular ductus ejaculatorius, cut off proximally from the vesicula granulorum by a valve, and extending distally into the male genital canal; bursa copulatrix present; female system regular,

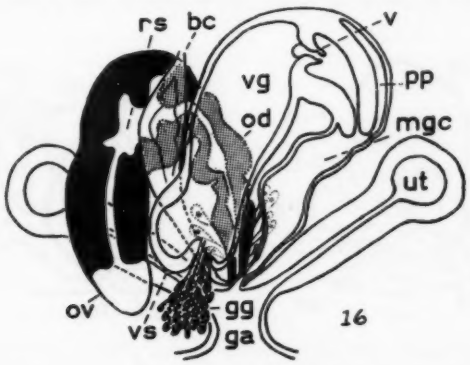


FIGURE 16. Diagrammatic anterior optical section of sex apparatus of *Mesostoma macroprostratum* Hyman. × ? After Hyman 1939.

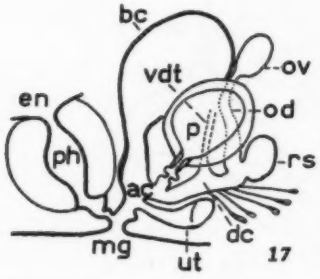
rather muscular; vitellaria follicular, lateral; receptaculum seminis thick-walled; paired uteri extending posteriorly and laterally; chromosomes unknown; body length 2.0–2.5 mm.; habitat: temporary pond, elevation 9700 feet, Medicine Bow Mts., Wyoming, U. S. A.

M. mutabile Böhmig 1902, *M. m.*, Böhmig in: Ergeb. Hamb. Magalh.-Sammelr., v. 3, Turbell., p. 4, pl. 1, f. 1–5. / 1904, *M. m.*, Luther in: Z. wiss. Zool., v. 77, p. 235, pl. 1, f. 25, 27, 36; pl. 2, f. 1, 2; pl. 5, f.

* Hyman has commented on the difficulty of assigning a member of the Typhloplanidae to its proper genus without a knowledge of the testes. The authors feel that Hyman's disposal of the animal under discussion is justified, since the animal could not be made to fit any other genus even if the testes were assumed to be ventral and since it does fit the genus *Mesostoma* if the testes are assumed to be dorsal to the vitellaria.

18–28, 37, 39. / 1938, *M. m.*, Kepner, Ferguson and Stirewalt in: Zool. Anz., v. 121, p. 313. / 1939, *M. m.*, Ruebush in: Zool. Anz., v. 126, p. 64.

Form of the body similar (Fig. 17) to that of *M. craci* with four more or less extruded wing-like flaps, the cross-section quadrangular or nearly round, the anterior end Russel-like; body white with net-like pigment in the mesenchyme ventrally and in the region of the sex organs and pharynx; rhabdites spindle-shaped, 10–18 μ long and 2 μ thick, broadly pointed at the ends, abundant over all the body except the anterior end; long, thin, serpentine rhammites present all over the body but especially in the anterior rodways that open ventrally just behind the anterior tip of the body; cyanophylic glands also present, the ducts



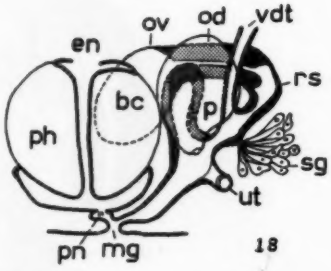


FIGURE 17. Diagrammatic lateral optical section of sex apparatus of *Mesostoma mutabile* Bohmig. × ? After Bohmig 1902.

FIGURE 18. Diagrammatic left lateral optical section of sex apparatus of *Mesostoma productum* (O. Schmidt). × 235. After Luther 1904.

opening ventrally between the brain and the anterior end; eyes somewhat farther apart than in *M. craci*. Excretory system typical; mouth and gonopore combined; testes lateral, above the enteron, extending from the middle of the body to the posterior tip, anastomosed at the posterior end and sometimes at the anterior part or in the middle; vasa deferentia uniting shortly before entering the vertex of the vesicula seminalis; ducts of two kinds of granule glands entering the penis bulbus around the entrance of the vas deferens; bulbus of the penis spherical, distinctly smaller than the bursa; cuticular ductus ejaculatorius about 166 μ long opening into the atrium copulatorium cut off from the rest of the atrium by a sphincter; bursa with a large oval enlargement and a muscular stem; female system regular; receptaculum seminis a distension of

the germ duct; vitellaria papillose, extending from the brain to somewhat over the anterior ends of the testes; uteri simple; winter eggs from 1–8 per animal, brownish yellow in color, biconcave, .4–.5 mm. in diameter; length of the fixed animal 4 mm., breadth 1–2 mm.; habitat: fresh water pools of Uschuaia south Feuerland.

M. nigrorostrum M. Braun 1885, *M. n.*, M. Braun in: Arch. Dorpat. Ges., ser. 2, v. 10, p. 179, pl. 1, f. 3; pl. 2, f. 14, 15. / 1904, *M. n.*, Luther in: Z. wiss. Zool., v. 77, p. 249. / 1906, *M. n.*, Brinkmann in: Vid. Meddel., v. 58, p. 97, pl. 4, f. 5–14; textf. 9, 10. / 1909, *M. n.*, L. Graff in: Brauer, Sussw., v. 19, p. 126, f. 234. / 1938, *M. n.*, Hyman in: Amer. Mus. Novitates, no. 1005, p. 4. / 1938, *M. n.*, Kepner, Ferguson and Stirewalt in: Zool. Anz., v. 121, p. 312. / 1939, *M. n.*, Ruebush in: Zool. Anz., vol. 126, p. 64.

Body elongate, broadest anteriorly, gradually narrowed to the usually rounded sometimes pointed posterior end, anterior end rounded and with a Russel-like tip whose cross-section is +-shaped, the keels of the Russel highest in the region of the eyes and diminished posteriorly where the cross-section is oval or circular; color greyish brown, the pigment aggregated into spherical masses in the mesenchyme anteriorly and into net-like configurations posteriorly, the color sometimes concentrated in the region of the brain, pharynx, and sex organs and usually greatest on the dorsal side, rhabdites crowded in the outer third of the epithelial cells; rhammites present in the anterior rodways opening at the Russel-like tip; eyes black, placed rather far forward, equidistant from one another and the sides of the body, and provided with lenses; excretory system typical; mouth anterior to the middle of the body, opening into a common depression with the gonopore; testes similar in form and extent to those of *M. craci:* vasa deferentia opening into the vertex of the copulatory organ; general form of the penis bulbus similar to that of *M. rhynchotum;* ductus ejaculatorius lined by a thick-walled cuticular tube little widened at the basal end and bearing at the outer edge a row of very fine points, the cross-section of the cuticle showing two well-defined keels on the outside; bursa thin-walled, spherical; female system regular; receptaculum seminis a distension of the germ duct; vitellaria follicular, extending as far as the enteron and in contact with it except in the region of the pharynx and sex organs; uteri simple extending posteriorly; eggs thick-shelled, concavo-convex, reddish brown; summer eggs not known; length up to 6 mm.; habitat: moor pools in Dorpat and in Denmark; very sluggish, never known to swim.

M. platycephalum M. Braun 1885, *M. p.*, M. Braun in: Arch. Dorpat.

Ges., ser. 2, v. 10, p. 161, pl. 2, f. 9, 10. / 1904, *M. p.*, Luther in: Z. wiss. Zool., v. 77, p. 249. / 1909, *M. p.*, L. Graff in: Brauer, Süssw., v. 19, p. 126, f. 233. / 1938, *M. p.*, Kepner, Ferguson and Stirewalt in: Zool. Anz., v. 121, p. 312.

Body slender, provided with dorsal and ventral median keels, the posterior end pointed, the anterior end rounded and dorso-ventrally flattened; mesenchyme pigment red-brown; distributed over the whole body; rhammites long and thick, occurring in the rodways; brain at the end of the first body fifth and just in front of the enteron; eyes small, black, provided with lenses, and placed so close together that they are almost connected by a bridge; excretory system typical; testes elongate, band-form, divided in older individuals into several pieces; vasa deferentia opening one behind the other on the dorsal surface of the penis bulb; common genital atrium lined by a cuticular membrane; bursa small, spherical, not sharply set off from its stem; female system regular; receptaculum seminis a spherical distension of the germ duct; vitellaria follicular, ventral, extending the entire length of the enteron; uteri simple, extending posteriorly; eggs concavo-convex, reddish brown in color; length up to 4.5 mm.; habitat: fresh water pools, Dorpat, Russia.

M. productum (O. Schmidt.) 1774, *Fasciola grossa*, O. F. Müller, Verm. terr. fluv., v. 1–II, p. 67. / 1776, *Planaria g.*, O. F. Müller, Zool. Dan. Prodr., p. 222. / 1779, *P. g.*, Abildgaard in: O. F. Müller, Zool. Dan., ed. 3, v. 3, p. 40, pl. 105, f. 5. / ? 1826, *P. grisescens*, O. Fabricius in: Danske Selsk. Afh., v. 2, p. 19, pl. IE. / ? 1828, *Derostoma grossum*, Ant. Dugés in: Ann. Sci. nat., v. 15, p. 142, pl. 4, f. 6 / ? 1830, *D. g.*, Ant. Dugés in: Ann. Sci. nat., v. 21, p. 78, pl. 2, f. 15. / 1837, *Mesostoma grossum*, Ehrenberg in: Abh. Ak. Berlin, p. 244. / 1848, *Schizostomum productum*, O. Schmidt, Rhabd. Strudelw. süss. Wass., p. 59, pl. 6, f. 16, 16a. / 1854, *Mesostomum p.*, R. Leuckart in: Arch. Naturg., v. 20–II, p. 349. / 1858, *M. fallax*, O. Schmidt in: Denk. Ak. Wien, v. 15, p. 34, pl. 3, f. 6, 7. / 1862, *Turbella producta* + *T. f.*, Diesing in: SB. Ak. Wien, v. 45–I, p. 221. / 1882, *Mesostomum productum*, L. Graff, Monogr. Turbell., v. 1, p. 287. / 1885, *M. p.*, M. Braun in: Arch. Dorpat. Ges., ser. 2, v. 10, p. 156, pl. 2, f. 20. / ? 1890, *Mesostomum grossum*, L. Vaillant, Hist. nat. Annel., v. 3–II, p. 635, 642 pl., 28, f. 5. / 1894, *Mesostoma productum*, Hallez, Cat. Turbell., ed. 2, p. 70. / 1894, *M. p.*, Sekera in: Zool. Anz., v. 28, p. 236. / 1899, *Mesostomum p.*, Bresslau in: Zool. Anz., v. 22, p. 422, f. 4c, 4d. / 1902, *Mesostoma p.*, Dorner in: Schr. Ges. Konigsb., v. 43, p. 16. / 1903, *Mesostomum p.*, Bresslau in: Verh. D. zool. Ges., v. 13, p. 126. / 1904, *M. p.*, Luther in: Z. wiss.

Zool., v. 77, p. 218, pl. 1, f. 26; pl. 2, f. 3; pl. 5, f. 31, 41; pl. 7, f. 1; textf. 6, 10, 16. / 1904, *M. p.*, Markow in: Trudui Kharkov. Univ., v. 39, p. 36. / 1909, *M. p.*, L. Graff in: Brauer, Süssw., v. 19, p. 119. / 1938, *M. p.*, Kepner, Ferguson and Stirewalt in: Zool. Anz., v. 121, p. 313. / 1939, *M. p.*, Ruebush in: Zool. Anz., v. 126, p. 55, 57.

Body elongate (Fig. 18), the ends broadly pointed, the anterior end more acute than the posterior; epithelium clear but the body colored by oil drops and black-brown pigment granules, the latter organized into large branched clumps more abundant ventral to the enteron than dorsally; cilia of the dorsal side a half longer than those of the ventral side; rhabdites 3–4 μ long and as much as 0.5 μ thick, filling the peripheral part of the epithelial cells; rhammites rounded at one end and pointed at the other, 30 μ long and 1 μ thick in the anterior rodways, only about 10 μ long over the rest of the body; eyes composed of finely granular dark brown pigment cups placed close together and often connected by a bridge at the end of the first body sixth; excretory system regular; pharynx located at the margin of the first and second body thirds and opening together with the gonopore; dorsal lying testes weakly developed, sometimes according to Luther with only a single testis developed which then lies as an irregularly nodulated band dorsal to and slightly longer than the enteron;* vasa deferentia opening on the side of the blind end of the penis bulb that receives at the vertex the granule glands; copulatory organ thin-walled, retort-form, covered by two layers of spiral muscle; broad ductus ejaculatorius funnel-form at the proximal end and about 45 μ in length, provided with a cuticular lining; bursa thick-walled, provided with strong ring muscles; female system regular; receptaculum seminis usually a mere distension of the germ duct, sometimes an outpocketing from the duct; vitellaria strongly developed composed of an anterior and a posterior mass of follicles on each side, the follicles of each mass arranged about a central yolk duct, the two masses of each side separated by a length of yolk duct lacking follicles; uteri simple, extending posteriorly; summer eggs as many as 23 in one animal and often present at the same time with winter eggs; egg production essentially as in *M. ehrenbergii*; length 4.8 mm.; habitat: fresh water pools and lakes of Europe including Denmark, France, Germany, Switzerland (as much as 60 m. deep in Genfer Lake), Austria, Hungary, Russia (from Solowetzk to Odessa), and Asia (Tomsk).

* It would seem that this single testis might well be a fusion product as in *M. virginiana*.

M. punctatum M. Braun 1885, *M. p.*, M. Braun in: Arch. Dorpat. Ges., ser. 2, v. 10, p. 175, pl. 1, f. 2; pl. 2, f. 16–19. / 1904, *M. p.*, Luther in: Z. wiss. Zool., v. 77, p. 244. / 1904; *M. p.*, Markow in: Trudui Kharkov. Univ., v. 39, p. 32. / 1909, *M. p.*, L. Graff in: Brauer, Sussw., v. 19, p. 124. / 1938, *M. p.*, Kepner, Ferguson and Stirewalt in: Zool. Anz., v. 121, p. 312. / 1939, *M. p.*, Ruebush in: Zool. Anz., v. 126, p. 64, 65.

Body narrowed anteriorly and bluntly pointed, little narrowed posteriorly and rounded at the end, body plump, the cross-section of contracted or fixed animals quadrangular; ground color a bright greyish yellow with spots of brown or red-brown resulting from pigment cells in the mesenchyme; rhammites present in the anterior rodways and more sparingly on the ventral surface; eyes composed of lense-provided pigment cups, dark brown in reflected light, black in transmitted light, placed at the end of the first body fifth and about one half as far apart as from the sides of the body; excretory system typical; pharynx lying in the middle or somewhat behind the middle of the body; mouth and gonopore not combined; testes elongate, ribbon-shaped, dorsal to but not as long as the enteron; copulatory organ pear-shaped, provided with thick muscular walls; penis short and conical, covered both inside and out with a cuticular membrane; bursa muscular, spherical or oval, and provided with a short stalk, the whole organ covered by a glistening membrane; female system regular; receptaculum a spherical diverticulum of the germ duct; vitellaria elongate, follicular or papillose; uteri simple, extending posteriorly; eggs 3–4 per animal, reddish brown in color, the shells concavo-convex, and 0.4 mm. across; length up to 5 mm.; habitat: fresh water of Russia (Livland, Charkow).

M. rhynchotum Braun 1885, *M. r.*, M. Braun in: Arch. Dorpat. Ges., ser. 2, v. 10, p. 173, t. 1, f. 6, t. 3, f. 7–10. / 1904, *M. r.*, Luther in: Z. wiss. Zool., v. 77, p. 248. / 1906, *M. rhynchotum*, Brinkhmann in: Vid. Meddel., v. 58, p. 102, t. 4, f. 15, 16; tf. 11, 12 (Anat). / 1909, *M. rhynchotum*, L. Graff in: Brauer. Süssw., v. 19, p. 125, f. 232. / 1913, *M. r.*, L. Graff in: Das Tierreich, v. 35, p. 283, f. 247. / 1938, *M. r.*, Hyman in: Amer. Museum Novitates, No. 1005, p. 4. / 1939, *M. r.*, Ruebush in: Zool. Anz., v. 126, p. 63, 64.

Body plump, anteriorly narrowed with small, protrusible, almost Russel-like projection, posteriorly broadly rounded with small projecting tail; pigment greyish brown, parenchymal, enteron darker; eyes close together, black, often with a tinge of cherry red; excretory system undescribed; gonopore immediately posterior to mouth; testes cylindrical, compact, dorsal, without anastomosis; ductus seminalis short;

penis bulb thickly muscular, pyriform, containing both vesicula seminalis and vesicula granulorum; ductus ejaculatorius cuticular, widened at the base into a sort of funnel; female reproductive system regular; vitellaria follicular, lateral; bursa copulatrix with cuticular lining, the wall of strong circular muscles; uteri posterior; chromosomes unknown; body length up to 3 mm.; habitat: fresh water Livlands and Denmark.

M. tetragonum (Müller) 1774, *Fasciola tetragona*, O. F. Müller, Verm. terr. fluv., v. 1–II, p. 69. / 1776, *Planaria t.*, O. F. Müller in: Zool. Dan. Prodr., p. 223. / 1789, *P. t.* (part.), Abildgaard in: O. F. Müller, Zool. Dan., ed. 3, v. 3, p. 42, pl. 106, f. 1–4. / 1836, *P. ehrenbergii* (part.), W. Focke in: Ann. Wien. Mus., v. 1–II, p. 202, pl. 17, f. 9, 10. / 1848, *Mesostomum tetragonum*, O. Schmidt, Rhabd. Strudelw. süss. Wass., p. 44, pl. 3, f. 8, 8c. / 1851, *M. t.*, M. Schultze, Beitr. Turbell., p. 9–32, pl. 1, f. 4–6, 18–20, 24, 25, 29, 31–34. / 1862, *Turbella tetragona* (part.), Diesing in: SB. Ak. Wien, v. 45–I, p. 221. / 1879, *Mesostomum t.*, Hallez in: Trav. Wimereux, v. 2, p. 44, 55, pl. 1, f. 3; pl. 6, f. 7, 11; pl. 10, f. 20. / 1885, *Mesostoma tetragonum*, M. Braun in: Arch. Dorpat. Ges., ser. 2, v. 10, p. 168, pl. 1, f. 1; pl. 4, f. 3. / 1894 *M. t.*, Hallez, Cat. Turbell., ed. 2, p. 73. / 1904, *M. t.*, Luther in: Z. wiss. Zool., v. 77, p. 244, pl. 2, f. 15; pl. 4, f. 18, 20, 22; pl. 5, f. 32, 38; pl. 7, f. 2; textf. 7, 9 E. / 1909, *M. t.*, L. Graff in: Brauer, Süssw., v. 19, p. 124, f. 133 E, 230, 231. / 1939, *M. t.*, Ruebush in: Zool. Anz., v. 126, p. 64.

Body (Fig. 19) a third or more as wide as long, four cornered in cross-section and provided with four lamellae of which the ventral pair is always somewhat broader; color reddish yellow or almost transparent; rhabdites about 2 μ long, numerous in the peripheral part of the epithelial cells; rhammites 50 μ long and 4 μ thick, long, coiled, and somewhat thickened at one end, abundant in the anterior rodways and to a lesser extent at the angles or the lamellae; mucous or spinning glands numerous on the ventral surface; eyes black, provided with lenses, placed close together over the brain and shortly in front of the enteron; excretory system regular; pharynx proportionately small; placed somewhat behind the middle of the body; oesophagus receiving a ring of long-stemmed glands; enteron rod-shaped, extending an equal distance anteriorly and posteriorly from the pharynx; gonopore clearly separated from the mouth; testes dorsal, composed of three pairs of clusters of follicles, one pair placed at the level of the pharynx, one at the middle of the anterior branch of the enteron, and the third at the middle of the posterior branch of the enteron; vasa eferentia from the various clusters uniting to form the paired vasa deferentia; the latter entering the vertex

of the penis bulb between the ducts of the two sorts of granule glands; penis bulbus oval in shape, provided with a strong musculature of four layers, the inner circular layer stronger than the outer longitudinal and two intermediate spiral layers taken together; vesicular seminalis and vesicula granulorum situated beside one another in the bulbus; ductus ejaculatorius lined by cuticle, widened funnel-like at the basal end, the whole about 176 μ long; bursa copulatrix large, provided with a stem and unusually strong ring muscles; female system regular; receptaculum seminis a swelling of the germ duct; vitellaria follicular, the follicles somewhat shorter than those of *M. craci*; uteri ⊦-shaped, containing as

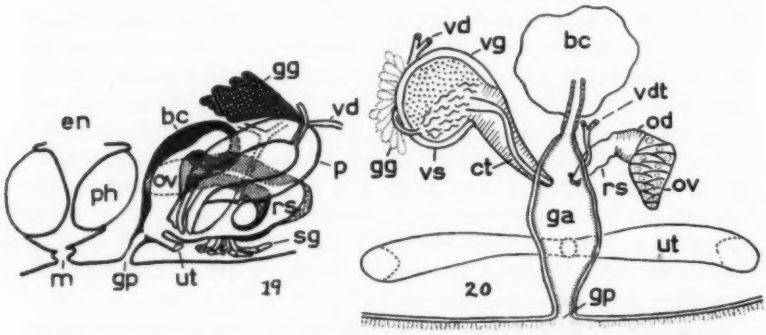


FIGURE 19. Diagrammatic left lateral optical section of sex apparatus of *Mesostoma tetragonum* (Müller). × 62. After Luther 1904.

FIGURE 20. Diagrammatic anterior optical section of sex apparatus of *Mesostoma togarmensis* Ruebush. × 45. After Ruebush 1939.

many as 120 eggs per animal; eggs concavo- or plano-convex, sometimes biconcave; length 10 mm., seldom over 12 mm.; habitat: freshwater of England, Denmark, Holland, France, Germany, Switzerland, Austria, Russia (Dorpat, Saratow).

M. togarmensis Ruebush 1939, *M. t.*, Ruebush in: Zool. Anz., v. 126, 3/4, p. 57–60, 61, 62, 63, 65, 66, f. 4, 5.

Body bluntly rounded anteriorly (Fig. 20), widest in pharyngeal region, tapering to a point posteriorly; pigment dark brown, parenchymal; eyes large; rhabdites present in cellular epithelium and rhammites in anterior tracts; excretory system undescribed; mouth and gonopore combined; testes elongate, anastomosing anteriorly and posteriorly; bulbus of penis with an inner layer of circular muscle; ductus ejacula-

torius an elongate, highly differentiated, curved, cutilarized tube (280 μ); female genital system regular; receptaculum seminis cut off by a sphincter from the undivided genital atrium; vitellaria follicular; paired uteri extending latero-posteriorly from the common uterine pore in the basal part of the atrium; bursa copulatrix a thin-walled muscular bladder with a thin, highly muscular stalk cut off from the atrium by a sphincter; chromosomes: N = 4, 2N = 8; body length up to 3 mm.; habitat: Togarma Tso, Tibet.

Mesostomum virginiana K., F., and S. 1938, *Mesostomum virginianum* Kepner, Ferguson, and Stirewalt in: Zool. Anz., v. 121, 11/12, p. 307–313. / 1939, *Mesostoma virginiana*, Ruebush in: Zool. Anz., v. 126, 3/4, p. 64. / 1939, *M. v.*, Hyman in: Amer. Midland Nat., v. 21, iii, p. 646.

Body oblanceolate (Fig. 6), the smaller end anterior; pliable lateral body flaps present; color chocolate brown; rhabdite tracts open anteriorly by two groups of minute pores; dermal rhabdites (2 μ) closely packed in cellular epidermis; eyes black, crescent-shaped, irregular, often anastomosing; excretory system regular; mouth slightly anterior to mid-body; gonopore separate from mouth; large dorsal testis compound, the anastomosis of the two units almost complete; vasa deferentia short; bulbus of penis containing both the vesicula seminalis and the granulorum; penis papilla containing a short, cuticular ductus ejaculatorius and diminutive blind sac; atrium copulatorium present; ovary small and oval; oviduct thick-walled, receptaculum seminis a muscular dilation of the oviduct; paired uteri extending latero-posteriorly; vitellaria aboreal; bursa copulatrix Florence flask-shaped; common genital atrium divided into superior and inferior genital atria; chromosomes: N = 4, 2N = 8; body length 3 mm.; habitat: high mountain swamps, Green County, Virginia, U. S. A.

LIST OF SPECIES NOT ACCEPTED IN THE GENUS *Mesostoma*

(Although *Mesostoma* is the older and correct spelling of the genus name, the form *Mesostomum* seems to have been used quite as much. In the following list the form used by the author in question is retained.)

Mesostomum agile Levinsen 1879, transferred to *Promesostoma a.* by L. Graff in: Monogr. Turbell., v. 1, p. 274, 1882.

Mesostomum agilis Levinsen 1879, transferred to *Maehrenthalia* by L. Graff in: Z. wiss. Zool., v. 83, p. 97, 1905.

Mesostoma ajpetri Nassonov 1923, relegated to *species dubiae* by Kepner, Ferguson, and Stirewalt in: Zool. Anz., v. 121, 11/12, p. 313, 1938.

Mesostoma andicola Schmarda 1859, relegated to *species dubiae Rhabdocoelorum* by Luther in: Z. wiss. Zool., v. 77, p. 279, 1904.

Mesostoma angulare Higley 1918, relegated to *species dubiae* by Hyman in Amer. Midland Naturalist, v. 22, iii, p. 633, 1939.

Mesostoma antarcticum Dreyer 1918, declared to be incompletely described and almost identical to *M. mutabile* (which see) by Ruebush in: Zool. Anz., v. 126, 3/4, p. 64, 1939.

Mesostoma armatum Fuhrmann 1894, transferred to *Castrada armata* by Luther in: Z. wiss. Zool., v. 77, p. 212, 1904.

Mesostoma aselli Kennel 1898, assigned to *species dubiae* by Luther in: Z. wiss. Zool., v. 77, p. 259, 1904.

Mesostoma auditivum Forell (?) and Du Plessis 1874, transferred several times and finally to *Otomesostoma a.* by Hofsten in: Z. wiss. Zool., v. 85, p. 555, 1907.

Mesostomum bacilliferum Diesing 1862. Poorly and incompletely described.

Mesostoma balatonicum Szigethy 1897, relegated to *species dubiae* by Luther in: Z. wiss. Zool., v. 77, p. 259, 1904.

Mesostomum banaticum Graff 1875. The animal lacks a bursa copulatrix and because of this as well as the anatomy of the vitellaria and testes, it is obviously not a *Mesostoma*. The worm is not sufficiently well described to be assigned to a genus.

Mesostomum bifidum McIntosh 1875, transferred many times and finally assigned to *Astorhynchus bifidus* by Graff in: Das Tierreich, v. 35, p. 177, 1913.

Mesostomum bistrigatum Oersted 1844 (?). Poorly and incompletely described.

Mesostomum chlorosticum O. Schmidt 1857, relegated to *species dubiae Rhabdocoelorum* by L. Graff in: Das Tierreich, v. 35, p. 353, 1913.

Mesostoma climenti Nassonov 1923, relegated to *species dubiae* by Kepner, Ferguson, and Stirewalt in: Zool. Anz., v. 121, 11/12, p. 313, 1938.

Mesostoma coecum Silliman, 1884 & 1885, transferred to *Olisthanella coeca* by Luther in: Z. wiss. Zool., v. 77, p. 148, 1904.

Mesostoma cuenoti Dorner 1900, transferred to *Castrada c.* by Luther in: Z. wiss. Zool., v. 77, p. 186, 1904.

Mesostoma cyathus O. Schmidt 1858, declared identical to *Turbella lingua* (same as *Mesostoma lingua*) by Diesing in: SB. Ak. Wien, v. 45, I, p. 220–221, 1862.

Mesostoma cyathus Dorner 1902, declared identical to *M. chromobractrum* by Luther in: Z. Wiss. Zool., v. 77, p. 227, 1904.

Mesostoma cycloposthe Dorner 1902, declared identical to *M. armatum* (which see) by Luther in: Z. wiss. Zool., v. 77, p. 212, 1904.

Mesostomum echinatum Uljanin 1870, transferred to *Prozenetes echinatus* by L. Graff in: Monogr. Turbell., v. 1, p. 283, 1882; but relegated to *species dubiae* by Graff in: Das Tierreich, v. 35, p. 200, 1913.

Mesostomum ellipticum Uljanin 1870, transferred to *Promesostoma e.* by L. Graff in: Monogr. Turbell., v. 1, p. 273, 1882.

Mesostomum ensifer Uljanin 1870, declared identical to *Promesostoma marmoratum* by L. Graff in: Monogr. Turbell., v. 1, p. 269, 1882.

Mesostoma exiguum Dorner 1902, transferred by Luther to *Olisthanella exigua* in: Z. wiss. Zool., v. 77, p. 148, 1904.

Mesostomum fallax O. Schmidt 1858, declared identical to *Turbella producta* (same as *Mesostoma productum*) by Diesing in: SB. Ak. Wien, v. 45, I, p. 221, 1862.

Mesostoma flavida Graff 1882, transferred to *Castrada flavida* by Luther in: Z. wiss. Zool., v. 77, p. 183, 1904.

Mesostoma fusiforme Duges 1830, relegated to *species dubiae* by Luther in: Z. wiss. Zool., v. 77, p. 259, 1904.

Mesostoma gangetica Dutta 1925, relegated to *species dubiae* by Ruebush in Zool. Anz., v. 126, 3/4, p. 45, 1939.

Mesostoma gonocephalum Silliman 1884, transferred to *Strongylostoma g.* by L. Graff in: Z. wiss. Zool., v. 99, p. 56, 1911.

Mesostoma gracile Schmarda 1859, relegated to *species dubiae* by Luther in: Z. wiss. Zool., v. 77, p. 259, 1904.

Mesostoma graffi Mereschkowsky 1879, transferred to *Promesostoma g.* by L. Graff in: Monogr. Turbell., v. 1, p. 273, 1882.

Mesostoma griseum O. F. Müller 1789, relegated to *species dubiae* by Luther in: Z. wiss. Zool., v. 77, p. 259, 1904.

Mesostoma grossum Ehrenberg 1837, equivalent to *M. productum*.

Mesostomum hallezianum Vejdovsky 1880, transferred several times and finally to *Olisthanella halleziana* by L. Graff in Brauer, Sussw., v. 19, p. 101, 1909.

Mesostomum herclotisanum de Man 1874, declared identical to *Strongylostoma radiatum* by Luther in: Z. wiss. Zool., v. 77, p. 149, 1904 .

Mesostomum hirudo O. Schmidt 1858, transferred several times and finally placed with reservation as *Castrada h.* by Hofsten in: Z. wiss. Zool., v. 85, p. 445, 1907.

Mesostoma hystrix Schmarda 1859, relegated to *species dubiae* by Luther in: Z. wiss. Zool., v. 77, p. 259, 1904.

Mesostoma karrooense Dreyer 1914. The animal is incompletely described, but differs from other *Mesostoma* in lacking a well-defined bursa copulatrix and in the possession of a "vagina" (sic), a specialized portion of the ductus communis. So far as one can tell from the description the vitellaria are dorsal to the testes, a condition which at once removes the animal from the genus *Mesostoma*. Dreyer himself considered his specimens very atypical of the genus.

Mesostoma lacteum Neppi 1904, assigned to *species dubiae Mesostominorum* by Graff in: Das Tierreich, v. 35, p. 292, 1913.

Mesostoma lanceola Braun 1885, transferred to *Castrada l.* by Luther in: Z. wiss. Zool., v. 77, p. 186, 1904.

Mesostomum lapponicum Schmidt 1852. The animal is very poorly and incompletely described, but is obviously not a *Mesostoma*.

Mesostomum lenticulatum O. Schmidt 1852, transferred to *Promesostoma l.* by L. Graff in: Monogr. Turbell., v. 1, p. 274, 1882.

Mesostomum lugundense de Man 1874, placed tentatively with *Olisthanella* by L. Graff in: Das Tierreich, v. 35, p. 212, 1913. But already placed in *species dubiae* by Luther in: Z. wiss. Zool., v. 77, p. 148, 1904.

Mesostoma maculatum Hofsten 1917, recognized by Ruebush, 1939. Description poor.

Mesostomum marmoratum Schultze 1851, transferred to *Promesostoma* by L. Graff in: Monogr. Turbell., v. 1, p. 269, 1882.

Mesostomum marmoratum var. *gronlandica* Levinsen 1880, combined with species, see above.

Mesostomum marmoratum var. *maculata* Jensen 1878, combined with species, see above.

Mesostoma masovicum Dorner 1902, assigned to *species incertae Typhloplaninorum* by L. Graff in Das Tierreich, v. 35, p. 260, 1913.

Mesostoma metopoglea Schmarda 1859 (Graff 1882), relegated to *species dubiae Rhabdocoelorum* by Luther in: Zeit. f. wiss. Zool., v. 77, p. 216, 1904.

Mesostoma michaelseni Weiss 1909. This species is described as having the testes ventral to the vitellaria and therefore can not belong to the genus *Mesostoma*. The species may possibly belong in the sub-family Typhloplaninae.

Mesostoma minimum Fuhrmann 1894, transferred to *Typhloplana minima* by Luther in: Z. wiss. Zool., v. 77, p. 174, 1904.

Mesostomum montanum Graff 1875, declared identical to *Rhynchomesostoma rostratum* by Luther in: Z. wiss. Zool., v. 77, p. 158, 1904.

Mesostoma morgiense Du Plessis 1876, declared identical to *M. auditivum* (which see). For history see L. Graff in: Das Tierreich, v. 1, p. 442, 1913.

Mesostoma murmanicum Nassonov (full description, 1925). Nassonov was himself doubtful whether his specimens belonged to the genus *Mesostoma* and in the light of present knowledge they definitely do not. The position of the testes and some other features suggest strongly the genus *Castrada*.

Mesostomum nassonoffi Graff 1882, first described but not named by Nassonov in: Izv. Obshch. Moscov., v. 23, II, p. 44. Transferred to *Olisthanella n.* by Luther in: Z. wiss. Zool., v. 77, p. 148, 1904.

Mesostoma neapolitanum Graff 1882, transferred to *Paramesostoma n.* by Attems: in: Wiss. Meeresunters., v. 21, p. 223, 231, 1897.

Mesostoma normatum Fuhrmann 1894, same as *M. perspicuum* (which see).

Mesostomum obtusum M. Schultze 1851, transferred several times and finally to *Olisthanella o.* by Luther in: Z. wiss. Zool., v. 77, p. 148, 1904.

Mesostoma oscari Graff in 1903, transferred within the genus and finally to *M. craci* (which see) by L. Graff in: Das Tierreich, v. 35, p. 276, 1913.

Mesostomum ovoideum O. Schmidt, 1852, transferred in part to *Promesostoma ovoideum* by Graff in: Monogr. Turbell., v. 1, p. 272; in part to *P. solea* by L. Graff in: ibid., p. 273, 1882.

Mesostoma pattersoni Silliman 1884, assigned to *species dubiae Typhloplanidarum* by Luther in: Z. wiss. Zool., v. 77, p. 259, 1904.

Mesostomum personatum O. Schmidt 1848, transferred to *Bothriomesostoma p.* by Braun in: Arch. Dorpat. Ges., ser. 2, v. 10, p. 187, 1885.

Mesostoma perspicuum Fuhrmann 1894, transferred to *Castrada perspicua* by Luther in: Z. wiss. Zool., v. 77, p. 183, 1904.

Mesostoma platygastricum Steinbock, recognized by Ruebush 1939. Description poor.

Mesostoma pusillum Schmidt 1848, relegated to *species dubiae* by Luther in: Z. wiss. Zod., v. 77, p. 259, 1904.

Mesostomum radiatum Diesing 1850, transferred several times and finally to *Strongylostoma r.* by Luther in: Z. wiss. Zool., v. 77, p. 149, 1904.

Mesostoma raugeense Braun 1885, assigned to *species incertae Typhloplanorum* by Luther in: Die Eumesostominen, II. Spezeiller Teil, Zeit. f. wiss. Zool., v. 77, p. 166, 1904.

Mesostoma robertsonii Graff 1882, declared identical to *Tetracelis marmorosa* by Luther in: Z. wiss. Zool., v. 77, p. 166, 1904.

Mesostoma rostratum Ehrenberg, 1836, transferred many times and finally to *Rynchomesostoma r.* by Luther in: Z. wiss. Zool., v. 77, p. 157, 1904.

Mesostomum rostratum Hallez 1879, declared identical to *Strongylostoma radiatum* by Luther in: Z. wiss. Zool., v. 77, p. 149, 1904.

Mesostomum segne Fuhrmann 1894, transferred to *Castrada s.* by Luther in: Z. wiss. Zool., v. 77, p. 177, 1904.

Mesostomum sensitivum Uljanin 1870, transferred to *Prozenetes sensitivus* by L. Graff in: Monogr. Turbell., v. 1, p. 282, 1882.

Mesostomum sigmoideum Plotnikow 1905, declared identical to *Mesostoma lingua* by Graff in: Das Tierreich, v. 35, p. 269, 1913.

Mesostoma simplex Higley 1918, relegated to *species dubiae* by Hyman in: Amer. Midland Naturalist, v. 22, iii, p. 633, 1939.

Mesostomum solea O. Schmidt 1857, transferred in part to *Promesostoma* by L. Graff in: Monogr. Turbell., v. 1, p. 273, 1882.

Mesostoma splendidum Graff 1882, transferred to *Olisthanella splendida* by Luther in: Z. wiss. Zool., v. 77, p. 147, 1904.

Mesostomum stagni (Dalyell) Leuchkart 1859. See Diesing in: SB. Ak. Wiss. Math. Natur. Cl. Wien, p. 224, 1862.

Mesostoma stimulosum Graff (1879) 1903, assigned to *species incertae* Typhloplanorum by Luther in Die Eurnesostominen. II. Spezieller Teil, Zeit. f. Wiss. Zool., v. 77, p. 216, 1904.

Mesostomum striatum Uljanin 1870, transferred to *Prozenetes* (?) *striatus* by L. Graff in Monogr. Turbell., v. 1, p. 283; but relegated to *species dubiae* by Graff in: Das Tierreich, v. 35, p. 200, 1913.

Mesostoma strigatum O. F. Müller 1773, relegated to *species dubiae* by Luther in Z. wiss. Zool., v. 77, p. 259, 1904.

Mesostomum sulphureum, de Mann 1874, transferred several times and finally to *Castrada intermedia* by Luther in: Z. wiss. Zool., v. 77, p. 209, 1904.

Mesostomum tetragonum (O. Müller) Schmidt, 1848, transferred in part to *M. craci* by L. Graff in: Monogr. Turbell., v. 1, p. 295, p. 298, 1882. It must be noted that the name, *tetragonum*, applies to an accepted species (which see).

Mesostomum trunculum O. Schmidt 1858, transferred many times and finally to *Olisthanella t.* by Luther in: Z. wiss. Zool., v. 77, p. 148, 1904.

Mesostoma uljanini Sabussow 1900, transferred to *Bothriomesostoma essenii* by Luther in: Z. wiss. Zool., v. 77, p. 249, 1904.

Mesostomum variable Weismann 1864, declared identical to *M. rostratum* (which see); for history see Graff in: Das Tierreich, v. 35, p. 220, 1913.

Mesostoma vedovskyi Jaworowski 1893, declared identical to *M. hallezianum* (which see) by Sekera in: Zool. Anz., v. 27, p. 435, 1904.

Mesostomum violaceum Levinsen (1879?) 1880, declared identical to *Promesostoma ovoideum* by Graff in: Z. wiss. Zool., v. 83, p. 89, 1905.

Mesostomum viridatum M. Schultze 1851, transferred in part to *Typhloplana viridata* by Luther in: Z. wiss. Zool., v. 77, p. 173, 1904.

Mesostoma viridis Pereyaslawzewa 1892, *nomen nudum*.

Mesostoma vivaparum Silliman 1884, declared identical to *M. viridatum* (which see) by Woodworth in: Bull. Mus. Harvard, v. 29, p. 241–242, 1901.

Mesostomum wandae O. Schmidt 1858, declared identical to *M. rostratum* Ehrenberg (which see) by Diesing in: SB Ak. Wien, v. 45, I, p. 220–222, 1862.

Mesostomum wandae Nassonov 1877, declared identical to *Strongylostoma radiatum* by Luther in: Z. wiss. Zool., v. 77, p. 149, 1904.

Mesostoma wardii Woodworth 1897, now classified not as a separate species, but as a variety of *M. ehrenbergii* by Ruebush 1940.

Mesostoma yungi Fuhrmann 1900, declared identical to *Tetracelis marmorosa* by Luther in: Z. wiss. Zool., v. 77, p. 166, 1904.

SUMMARY

The authors have essayed to make a careful study of the *Mesostoma* literature in order to evaluate and properly place the singularly few valid species and to bring together a more complete list of *species dubiae*. This latter list has grown inordinately, it seems, because of the improper designation of a large number of animals as mesostomes early in the history of the genus. This has been attended with an unprecedented carelessness in taxonomic differentiation. In order for the studies upon *Mesostoma* to improve, it is of the utmost importance that taxonomic characters be selected which display morphological differences and permanence, and that such flimsy, inconstant characters as "pigment" and "cross-section configuration" be deleted from the list of characters used for the determination of species. The valid species recognized by this study may easily be distinguished by the morphology of the organs composing the hermaphroditic sexual apparatus.

The members of *Mesostoma* have many interesting features which should invite further study of the genus. Especially noteworthy are the chromosomes which are large in size, small in number, and easy to distinguish one from another. It is suggested that the existence of such chromosomes in animals of complex, yet easily observable morphology, is conducive to genetic as well as cytological study. It is further suggested that the size and translucency of some of the species adapts them to convenient physiological study *in vivo*.

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STUDIES ON THE TURBELLARIAN FAUNA OF THE NORFOLK AREA

VI. Anatomy of *Macrostomum appendiculatum* var. *stirewalti* New Variety

By E. Ruffin Jones, Jr., and Frederick F. Ferguson

Plate 1

The Norfolk region presents an excellent opportunity for the study of marine and freshwater forms, because here may be found one of the most variable ecologic habitats in this country. Thus, it is not surprising that in a few months time we have gathered data upon nearly fifty new Turbellaria. This paper presents the microscopic anatomy of one of these, a new variety of a rhabdocoelid, *Macrostomum appendiculatum* var. *stirewalti*.*

Ecology.—This free-living worm inhabits the fresh water lakes of the water supply system of the City of Norfolk (Smith Lake and Little Creek Reservoir) and the series of ponds paralleling Shore Drive near Lynnhaven Inlet, Princess Anne County, Virginia. The animal was first taken in February, 1940, under a two inch layer of ice associated with an abundance of *Ricciocarpus*, *Sagittaria* and *Spirogyra*. Crustacea and Protozoa were also numerous. Altitude, about 4 feet. Geology, estuarine sand.

Description.**—Body colorless, dorsoventrally compressed (Fig. 1), anteriorly truncated, posteriorly slightly spatulate, broadest at mid-body level. Length *ca.* 1.5 mm. Epidermis of flat pentagonal cells bearing an even coat of cilia (*ca.* 5 μ). Sensory hairs overall, extremely long (*ca.* 45 μ) single and in groups of two and three. Spines confined to cephalic and caudal extremities. Rhabdoids abundant; rhabdites (*ca.* 13 μ) in groups of 7 to 9 overall except sub-anteriorly, sparse and single there (Fig. 4), *Stabchen* numerous, ventro-radially dispersed at female

* Named for Dr. M. A. Stirewalt in recognition of profound studies upon American Turbellaria. A research grant from the Virginia Academy facilitated this study.

** Measurements given are average figures taken from the study of many specimens.

gonopore (Fig. 9), *Rhammiten* abundant, anteriorly strongly developed above and below "brain" commissure. "Brain" of paired cerebral ganglia mesially united by restricted commissure, paired nerves course latero-longitudinally. Eyes (*ca.* 20 μ), black and paired (Fig. 3) disposed at postero-dorsal cerebral surfaces. Mouth limited by ciliated longitudinal lips, located antero-ventrally in mid-line. *Pharynx simplex* antero-ventral, abundantly supplied with latero-posteriorly directed system of slender pyriform pharyngeal glands (Fig. 2) bearing granules and *Rhammiten*. Enteron colorific, sac-like and extensive with ciliated endodermal epithelium. Excretory system of paired and separate lateral protonephridia each opening externally (Fig. 4) just meso-dorsal to anterior tip of the testes, terminal flame cells (Fig. 5) numerous. Testes obovate (Fig. 6), smooth-walled, located latero-ventral and only slightly posterior to anterior end of enteron. Vasa deferentia extending caudally from posterior extremity to each testis to unite just before entrance into vesicula seminalis. "False" vesicula seminalis not observed. Vesicula seminalis muscular, contractile and spheroidal, thin-walled when distended with sperm (Fig. 8), thick-walled when empty. Portal between sperm and granule sac controlled by sphincter. Vesicula granulorum muscular and contractile, proximally supplied with ciliated crypts, distally with rosette of granuliferous gland cells (Fig. 8) extending into genital canal of penis stilette. Penis stilette (Fig. 8) a conical tube housed in a muscular tunic, proximally truncated and crenate, distally attenuated and curved at *ca.* a right angle, opening long, sub-terminal and on convexity of apical flexure, greatest total length 50 μ, base 26 μ, stilette normally rests at *ca.* a 45° angle to longitudinal axis of body. Male gonopore ciliated and *ca.* 165 μ from posterior tip of body. Mature sperm cell (*ca.* 26 μ) highly mobile with anteriorly located hyaline granule (Fig. 7), *Nebengeisseln* lacking. Female genital system typical for genus. Ovary *ca.* one fourth as long as body. Eggs spherical and grayish brown (*ca.* 200 μ). Female genital atrium (Fig. 8) discrete, non-collapsible, finely ciliated, spheroidal. Female gonopore ventro-posterior in longitudinal mid-line, *ca.* 290 μ from posterior tip of body.

Taxonomic disposition.—Macrostomum appendiculatum var. *stirewalti* displays the specific characters of *Macrostomum appendiculatum* (O. Fabricius, 1826) Graff, 1905, but is delimited from this and other previously described representatives of *Macrostomum* as may be seen by reference to the key to the genus in Ferguson (1939–1940). In the

species the body is anteriorly blunt and posteriorly spatulate. The protonephridial system empties externally just posterior to the mouth and has a distinct caudal commissure. The sperm cell (*ca.* 50 μ) is a highly differentiated one possessing feeler, tail and body regions, plus lengthy paired *Nebengeisseln*. The penis stilette (*ca.* 59.8 μ) is relatively slender with a terminal lip or flange extending beyond the opening (see Ferguson, 1939, p. 51, Fig. 3). The numerous references to the species are given in the monograph on the genus by Ferguson (1939–1940).

Differential diagnosis.—Macrostomum appendiculatum var. *stirewalti*. Body anteriorly truncate, lacks marked spatulation, posteriorly colorless, length 1.5 mm. Rhabdites, *Stabchen* and *Rhammiten* abundant. Epidermal cilia, elongate sensory hairs and spines present. Protonephridia open dorsally at anterior tip of each testis. Vesicula granulorum with ciliated crypts and distal complement of granule glands. Penis stilette (*ca.* 50 μ) a conical tube with broad crenate base, lacking terminal lip or flange, opening at convexity of apical flexure, long and oval. Mature sperm cell elongate, threadlike (*ca.* 26 μ), lacking differentiation except for hyaline inclusion. Female sexual apparatus of usual type.

COLLEGE OF WILLIAM AND MARY—VIRGINIA POLYTECHNIC INSTITUTE
NORFOLK DIVISION AND U. S. P. H. S., CRANEY ISLAND.

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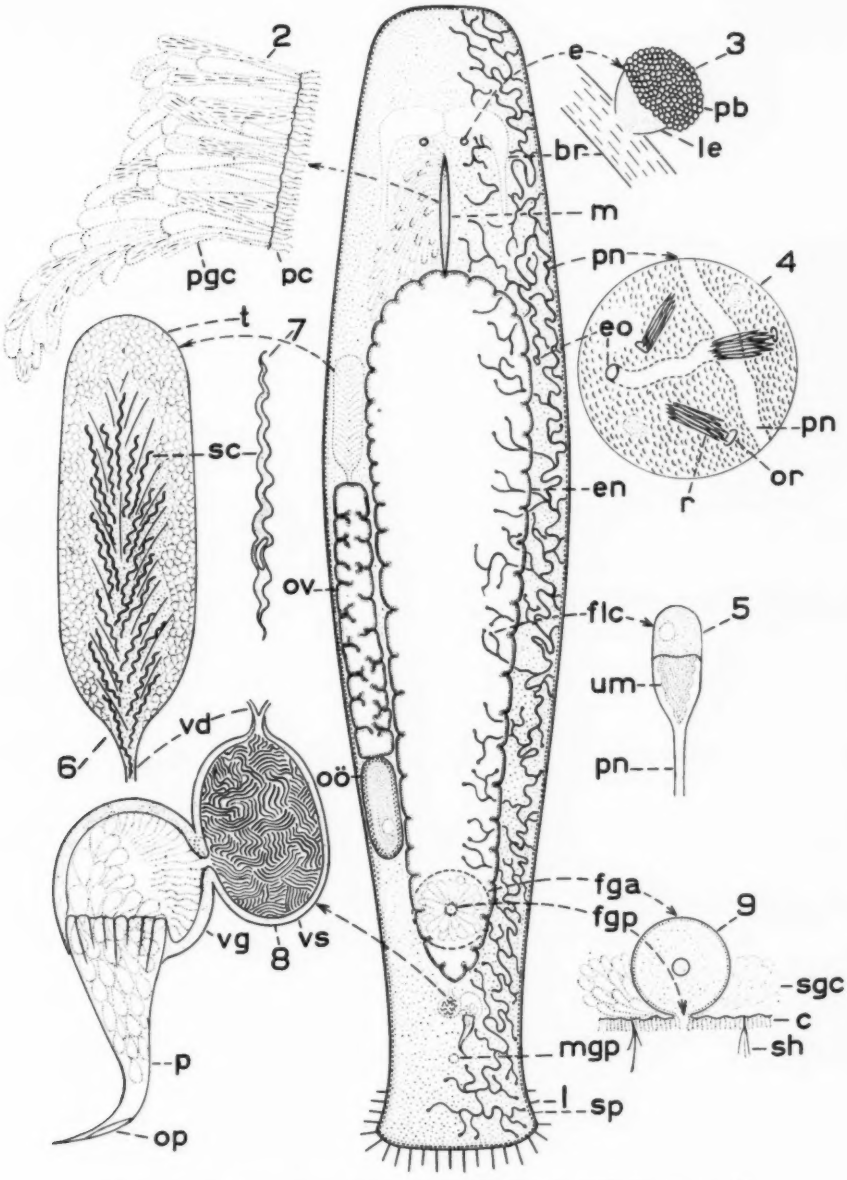
EXPLANATION OF PLATE 1

Fig. 1. Ventral view of gross anatomy. × 120.
Fig. 2. Optical section through wall of pharynx. × 750.
Fig. 3. Detail of "eye." × 675.
Fig. 4. Detail of external opening to protonephridia. × 750.
Fig. 5. Detail of terminal flame cell. × 525.
Fig. 6. Optical section through testis. × 300.
Fig. 7. Detail of mature sperm cell. × 1725.
Fig. 8. Dorsal view of male sex apparatus. × 675.
Fig. 9. Lateral view of terminal female genital apparatus. × 938.

ABBREVIATIONS USED

br—"brain"
c—epidermal cilia
e—"eye"
en—enteron
eo—external opening to protonephridia
fga—female genital atrium
fgp—female genital pore
flc—flame cell
le—"lens"
m—mouth
mgp—male genital pore
or—opening to rhabdite gland cell
op—opening to penis stilette
p—penis stilette
pb—pigment beaker
pgc—pharyngeal gland cells
pn—protonephridium
r—rhabdites
sgc—*Stabchen* gland cells
sh—sensory hairs
sc—sperm cell
sp—spines
t—testis
um—undulating membrane
vd—vas deferens
vg—vesicula granulorum
vs—vesicula seminalis

PLATE 1



ANATOMY OF MACROSTOMUM APPENDICULATUM VAR. STIREWALTI N. VAR.

THE FOOD AND FEEDING HABITS OF THE WHALE SHARK, *RHINEODON TYPUS*

By E. W. Gudger

INTRODUCTION

Of the many questions asked about the lives and living habits of fishes, one is sure to be—"How and on what does it feed?" This question is often asked about Rhineodon along with another—"Why is it called Whale Shark?" My answer is "Because it is a whale in size (it has been measured up to 45 ft. and estimated to reach 60 ft.) and in its manner of feeding." Then I would add that like a whale it swims along at the surface with open mouth, gathering in crabs, molluscs, jelly fishes, small fishes, and all the miscellaneous organisms which we call plankton. This is sieved out by its curious gill-arch structures, which function very like the whalebone of the whalebone whales.

But more exact data are wanted and in the long years that I have been studying the whale shark, I have noted in the literature a number of incidental references to the food and feeding habits of this great fish. In addition, many accounts have come from ship's officers from various regions where whale sharks have been observed. For these latter, I am under many obligations to the courteous and efficient services of the U. S. Hydrographic Office, and it is a pleasure to make this acknowledgment.

In another article (Gudger, 1941) I have figured and have described somewhat minutely the extraordinary feeding organs of this greatest of sharks—huge mouth, small teeth, and especially the curious gill sieves which are unlike any other gill rakers in any other fish in the world. Now as a general rule it is true that the largest sharks have (in comparison with other animals) large mouths with large teeth to feed on large food or at least on large fragments of food. But it has been shown for Rhineodon (Gudger, 1941) that while it has a cavernous mouth, its teeth are only about 1/8th of an inch in length in a 30-foot specimen. The huge mouth is necessary to take in the hogsheads of water out of which the curious gill structures sieve or filter the pints of plankton and the small crabs, squids, fishes, etc., on which it feeds. And now

first of all let us see on what the largest of the sharks has been alleged to feed.

RHINEODON HERBIVOROUS?

The man who, of all writers on the whale shark, had the best chance to study this giant fish and who did little with it, was E. Perceval Wright. Wright spent six months in the Seychelles Islands, western Indian Ocean, and saw numerous specimens, photographed two and dissected two. Yet his observations are set down more or less incidentally in four publications and his photographs were never published.

Because Wright (1870) found masses of algae in the stomachs of his two dissected specimens, he came to the absurd conclusion that these fish, although true sharks, were herbivorous. But in 1879 he wrote:

> I found large masses of algae in their stomachs, so that at one time I was inclined to think it was an herbivorous shark. Probably, however, it derives its nourishment, in part at least, from minute crustaceans and other oceanic animal forms, which may be taken in along with masses of floating weed, and then ejecting the water through the strange mesh-like structures that unite the edges of the great gill openings, obtain by so doing enough to swallow.

However, this idea of herbivorous nutrition in Rhineodon has persisted long. Thus Frau Weber-van Bosse saw in 1899 and discoursed in 1905 of whale sharks in Buton Strait between Buton and Muna Islands, Celebes Group. Of Rhineodon she says, "It is one of the gentlest of the family of sharks, for the reason that, so far as is known, it lives entirely on vegetable food." This is poor reasoning. The African buffalo also eats vegetable food, but nevertheless is probably the most dangerous animal in Africa.

THE INVERTEBRATE FOOD OF RHINEODON

As noted above, Wright somewhat changed his mind to the conclusion that the whale shark feeds on molluscs, etc., tangled up in the algae. Either by observations on the living fish or by dissection after death he had abundant opportunity to get at the facts.

It is perhaps well to state here, while we are at the Seychelles, that a former correspondent of mine at Mahé informed me that the fishermen in the islands told him in 1915, and again in 1919, that the "Chagrin" (the local name of Rhineodon) fed on the "vauve," the common name for a small octopus or, as I conjecture, a small squid. This I conclude since the squid like the whale shark is a pelagic animal, while the octopus is a bottom dweller.

This is confirmed by the statement by Van Kampen (1908) that Rhineodon feeds on squids. In May, 1907, a whale shark 5.75 meters long was harpooned in Batavia Bay and dissected by Van Kampen, who found in its stomach the distinctive "Sepia-Schalen"—"cuttlefish bones." Here is the absolute proof that Rhineodon feeds on cephalopod molluscs.

Haly (1883) merely notes of a Ceylon specimen that "the stomach contained a quantity of finely-divided red matter"—probably crustacean remains. Such Raven and I found (Gudger, 1936) in the stomach of the specimen taken off Fire Island Light, Long Island, in August 1935. Because of its red color this was judged to consist of the broken up hard parts of crustacean exoskeletons. A California correspondent has seen streams of reddish feces discharged from the cloaca of a floating whale shark. Gill (1905), on the basis of the minute teeth and the gill-arch straining apparatus, deduced the general conclusion that the food of our shark consists of copepods and other crustacea, small molluscs, and other floating small animals.

How Rhineodon Obtains Its Invertebrate Food

This has heretofore been a matter of conjecture, as has been shown above. And the man who first made the conjecture was Smith 92 years ago (1849). Let us read what he wrote and see whether it coincides with the facts. He says that—

> When our shark proceeds to feed, the first step it probably takes is to open its jaws to their full extent, in order to permit the mouth and pharynx to become filled with sea water. On that being accomplished, the jaws are probably closed, in order that the water shall, by muscular efforts in the pharynx, be propelled through the tubes in the branchiae, and forced thus to leave behind it whatever mollusca, &c., it may chance to contain.

From conjectures of the feeding habits and food of the whale shark, mainly made from 70 to 90 years ago, it is a far cry to the man who saw and photographed our fish in the act of swimming at the surface for the purpose of feeding on surface-dwelling organisms.

In June, 1938, Mr. E. R. Fenimore Johnson of Camden, N. J., while cruising in the Bahamas, ran into a school of about a dozen whale sharks swimming along with and around his boat. These ranged in size from about 18 to 30 feet. The individual sharks were spread out in no formation over an area of about a quarter of a mile square. An individual would swim over a small area and then turn and come back over it as if hunting for something. This sounded suspicious to me when I read

Mr. Johnson's letter, and it had looked so to him when he saw it. So he made a motion film of one or more of the sharks, and kindly gave a copy of this to the American Museum. When this picture was thrown on the screen, it seemed to me that the fish were feeding. Then when I put the film through the "movieola" so that I could stop it on any "frame" and study that picture at ease, I was convinced that the particular fish shown in certain "frames" was feeding.

When I reported this conclusion to Mr. Johnson, he answered that

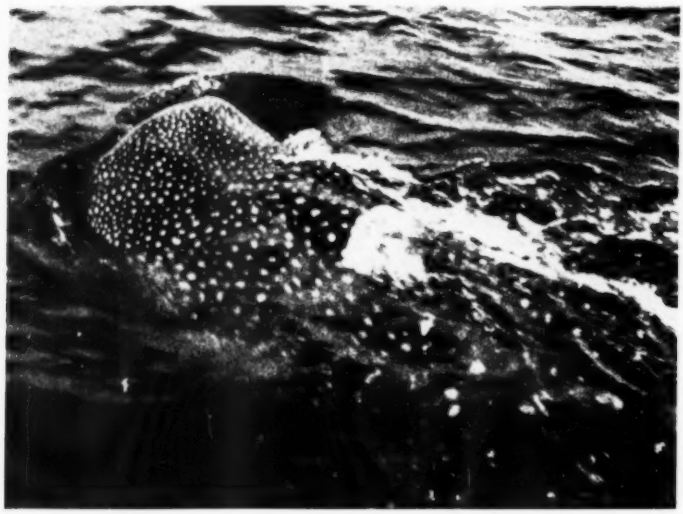


FIG. 1. The Whale Shark feeding at the surface of the sea

these whale sharks were certainly engaged in feeding. He said that a fish would swim for a few minutes with its huge mouth open and with its upper jaw about at the surface of the water. Then the fish would dive to a shallow depth for a brief interval and then come to the surface and repeat the manoeuvre. There is every reason to believe that it was feeding. Fig. 1 is one of the "frames" from Mr. Johnson's film showing this feeding. Curious to know what the fish could be seeking, Mr. Johnson dipped up pails of the sea water, but naked eye examination showed only scattered jellyfishes about 15 mm. in diameter. These surely made poor provender for this huge fish.

But there can be no doubt that these whale sharks were feeding on plankton at or near the surface of the water, and Mr. Johnson's film

gives the ocular proof. Thus he becomes the first person in the world to establish definitely by observation how Rhineodon obtains its invertebrate food. How the small invertebrate organisms are filtered out of the water has been carefully described in the article (Gudger, 1941) on the gill-arch structure, and need not be repeated here.

RHINEODON FEEDS ON FISHES

Rhineodon is a sluggish fish and does not use up energy like the more active swordfish, the spearfishes, the tuna and above all the bonito. This latter very active fish, according to John Davy, has a temperature nearly 10°C. higher than the surrounding water. On the other hand, the whale shark is the largest thing that swims the seas—the whales only excepted—and, even when loafing along, his huge body because of its very size, must use up much energy. To furnish this energy, a very large amount of food must be taken in.

The whalebone whales are also plankton-feeders, are rather sluggish swimmers, and have huge bodies—much larger than the whale shark's. To keep their great engines going, they too must have large quantities of food. This, because of their efficient oral sieving apparatus (plates of hair-fringed whalebone hanging from the roofs of their mouths), they obtain by straining it from great quantities of sea water. Now, the whalebone whales are high-latitude dwellers, and in those cold waters are found their invertebrate food in astronomical numbers and vast quantities. This, designated as "brit" by the whalemen, consists of small crustaceans of reddish color which occur in such great swarms as to discolor the surface of the sea for acres—the so-called "tomato-soup sea" of common parlance. So dense are these aggregations of this whale food in colder waters that, out of a "brit"-containing hogshead of water, gallons of food are obtained. Thus the whalebone whale is enabled to get the food required to keep his locomotor apparatus active.

In contrast, the whale shark lives in tropical and subtropical waters, and in the warm currents flowing out of and away from these waters. But in these warm waters there are no such aggregations of crustacean food for the whale shark as there are for the baleen whales in colder waters. Sometimes comparatively small and scattered aggregations (occasionally 10 feet in diameter) of crustacea, jellyfishes, etc., are found where whale sharks live, but these are so few and so scattering that the whale shark out of hogsheads of such water could obtain only pints of food. Even sluggish as the whale shark is, it could hardly be

expected by this feeding to get enough invertebrate food to keep its great engine going. Invertebrate food is not enough. Consequently I have long believed that Rhineodon must feed on small fishes. For this belief the proof is now at hand.

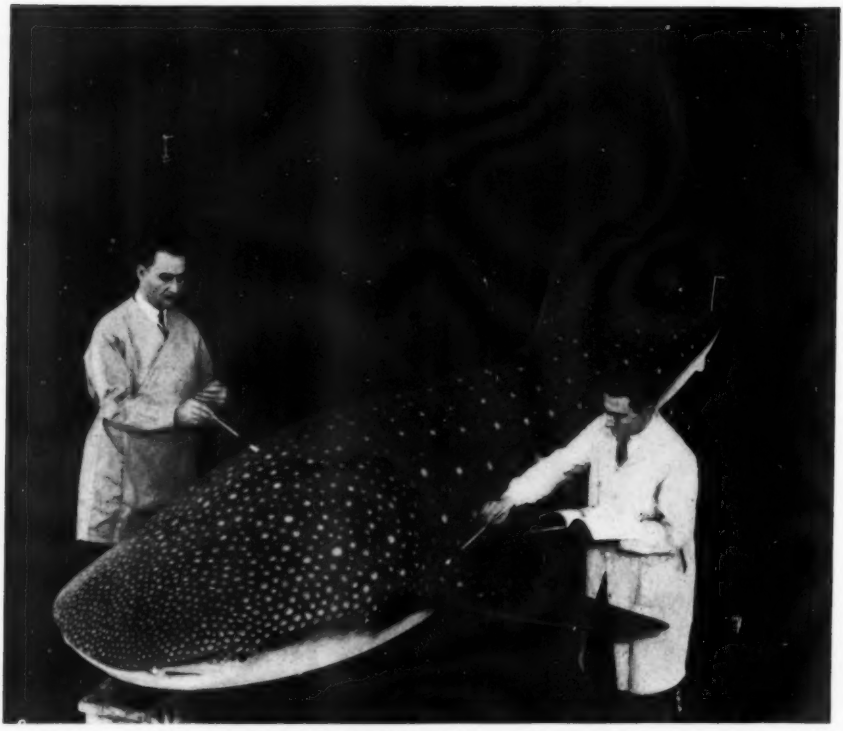


FIG. 2. The mounted skin of Rhineodon in the American Museum is having its spots restored

Miscellaneous Records of Fishes Eaten

The earliest accounts are merely scattered incidental notes and will be collected under the heading "Miscellaneous."

Tang.—So far as I know, the first writer to allege that the whale shark feeds on fishes is Günther. He wrote (1880, p. 324) that "It has been stated to feed on tang, an observation that needs confirmation." And it certainly does, for, though tang go in schools, they live around coral

reefs and hence would be safe from Rhineodon. While the tang is a rather small fish—6–12 in. long—it is a laterally-compressed and rather deep fish, its depth being contained in its length 1.5-2 times. It is a bit difficult to imagine such a fish going down the relatively small esophagus of the whale shark.

Sucking fish.—Kishinouye (1901) states that in the stomach of the specimen taken off Japan in 1901 a sucking fish was found. However, since the slender sucking fish are known to affix themselves to the upper part of the cavernous mouth of the whale shark, it would seem that this one had been swallowed by accident and not as a normal article of food.

Gobies, *Saurida.*—In 1908, Van Kampen published his brief note on the food of a Rhineodon taken in Batavia Bay, Java. In the stomach he found some small fishes—Gobies and one or more specimens of the coast-dwelling Synodontid genus *Saurida.*

Rhineodon Associates with Large Fishes but Feeds on Sardines

Now come accounts from five far-distant parts of the three warm oceans of an extraordinary association of Rhineodon with relatively large fishes—fishes too large for his small throat—but of his feeding on small fishes only. These small fishes are described as "sardines" and such they sometimes surely are, but the term probably covers all other small fishes taken in.

Whale Shark and Caranx at the Seychelles

The first dependable information as to the fish-eating proclivities of our great shark came to me from a valued correspondent at Mahé, Seychelles Islands, Western Indian Ocean. First in 1914, again in 1915 and 1919, and last in 1925, Mr. P. R. Dupont, Curator of the Botanic Station, wrote that the most reliable fishermen of the Seychelles reported that the "Chagrin" was associated with the "carangue balo," a caranx, but that it did not feed on it. Further questioning of the fishermen elicited the information that in the summer the SE tradewinds brought inshore to the islands great schools of "tauve," a kind of sardine, and of the caranx (*Caranx gymnostethoides*) which fed on the sardines. Furthermore they told him that the whale sharks were always at this time associated with the caranxes and that they also fed upon the sardines. So constant was the association of whale shark and caranx that the presence of a whale shark in the distance was a sure sign that the caranxes and sardines abounded, and when they saw it the fishermen set out with their nets confident of good fishing for the caranxes.

In every letter, Mr. Dupont warned me that this was what the fishermen reported, and that he himself had no proof of it whatever. However, from now to the end of the chapter, we will have the most amazing evidence in support of this "fisherman's tale."

Rhineodon and Bonito off Japan

Kishinouye has already been cited as having noted a sucking fish in the stomach of a Rhineodon taken off Cape Inubo, Japan. Seeking further information about the whale shark in the Kuro Sivo, I wrote Prof. Kishinouye and from his answering letter the following interesting data are excerpted:

> I am told that Rhineodon is quite common in the fishing-grounds of striped bonito off the eastern coast of Hondo.
> In the summer months, when the bonito fishing is busily carried on, the large shark comes to the surface of the sea, and seems to remain there basking. Around these sharks, the bonito crowd together.

At the time of receipt of this letter, I was busily engaged with other studies and being obsessed with the idea that the bonito had crowded around and probably under the whale shark to get in its shadow or to hide from enemies, I unfortunately did not pursue the inquiry further. Such inquiry is now impossible since Prof. Kishinouye has died. However, in the light of data already set out, it is more than likely that the whale sharks were seeking their food among the bonitos. Incidentally it may be noted that the striped bonito was the principal catch in the pound net off Fire Island Light into which the whale shark (previously referred to) blundered in 1935. It seems not improbable that here as off Japan whale shark and bonito were associated in seeking food.

Whale Sharks and Bonito in Cuban Waters

Dr. Luis Howell Rivero, head of the department of fishes in the Museo Poey of the University of Havana, writes that—"It is common knowledge that in Cuban waters, whale sharks and bonitos feed on and in schools of sardines. Upon coming to such a school, the whale sharks stand up vertically to feed. The bonitos do the same thing, leaping around to feed on the sardines. This fact causes the illusion that the whale sharks are feeding on the bonitos also." He also states that this association and feeding behavior have been observed in three Cuban localities, that the persons reporting these matters are personally known to him and that their veracity is unimpeachable. The accounts for these localities will now be presented.

Off Havana.—My first intimation of this interesting behavior of these fishes in this region came from Dr. W. H. Hoffmann of the Laboratorio Finlay in Havana. Dr. Hoffmann is a keen student of Rhineodon and has supplied me with invaluable data. He writes that the whale shark comes to the Havana region in the winter months along with great schools of sardines on which it feeds. These data came to him from different fishermen but as will be seen they agree in all essential details with accounts from other regions.

Later, other fishermen reported that in January and February the sardines in great schools come inshore from the Gulf Stream and that Rhineodon follows them. One fisherman stated that the sardines in the bays often leap out of the water as a result of the attacks by various predatory fishes. Another reported that he had seen the big shark feeding on the sardines out in the open sea, filling his mouth full and then swallowing them. Still another fisherman stated that he and his fellows had seen the whale shark standing nearly upright in a school of sardines and letting the small fishes jump into his open mouth. That this is not an isolated observation will now be seen.

In November, 1936, Dr. Carlos de Cardenas of Havana called at my office to discuss the whale shark. He told me that this feeding of our shark in a shoal of fish is a well-known phenomenon in Havana waters, but that it is reported that these fish are bonito. I suggested that Rhineodon, with the small gullet reported by Smith in 1849, could hardly swallow bonito which run from 8 to 15 pounds, and I urged that he make further and if possible personal observations. Recently Dr. Cardenas has written me on the subject as follows: "The whale shark is found in Cuban waters during the winter months feeding perpendicularly in schools of bonito and sardines. The opinion of fishermen here is that the bonito jump into the whale shark's mouth in trying to catch the sardines. At this time of the year it is rare to find a school of bonito in which there is not a whale shark in the middle." Dr. Cardenas states that various attempts have been made to take moving pictures of this feeding. And he has kindly promised that, if he learns of a successful attempt, he will endeavor to procure and send a copy of the film to me. This is a great desideratum.

Dr. Rivero, as noted above, corroborates the reports of Dr. Hoffmann and Dr. Cardenas for Havana waters. He has kindly communicated like information as to the behavior of all these fishes in two other localities. These now follow.

Off Manzanillo.—Dr. Rivero has kindly supplied me with data for

whale sharks and bonitos fishing in this locality, which is on the great bay on the SE shore of Cuba. He states that:

The Manzanillo records, which have been furnished by a medical doctor and fishing sportsman, state that in open waters, and also when schools of sardines approach the shore, the whale sharks have been seen to stand upright to feed on them. Then the bonitos, chasing the sardines, leap around and among them, making a great disturbance and feeding on them also. The sardines are very abundant here and this behavior has been observed more than once.

Off Gibara and Vita.—These localities are on the northern coast of the far eastern end of Cuba. Off these localities 40-foot whale sharks have been harpooned. The accounts of the occurrence and behavior of whale sharks, bonitos and sardines in these waters are less detailed than those which precede but Dr. Rivero states that the behavior of these fishes is essentially the same and that I may list these localities on his authority.

This behavior of these fishes is an exceedingly interesting phenomenon. Whale sharks and bonitos are plainly competing for food—sardines. When the whale shark gets his mouth full of the small fish, it is possible that he may elevate his head to facilitate the passage of water out through his gill slits. Here then we get the vertical position. In the meantime the savage bonitos charge into the school of sardines, and they and the terrified little fish are leaping and splashing—making a great commotion in the water. In this leaping of the bonitos after the sardines, the larger fish are more visible and would surely catch the eye, while the little sardines would not be noticed—if the fishermen are at a little distance. All this phenomenon then, to a non-scientific and non-critical observer at some distance, would appear as if the bonitos were leaping into the mouth of the great shark.

What I cannot understand is the alleged vertical position of the open-mouthed whale shark. If Dr. Cardenas shall be so fortunate as to get a motion film of this performance, critical examination of this frame by frame in a "movieola" will demonstrate the facts.

Rhineodon and Tuna in the Bahamas

Capt. Tom Gifford, the well known fishing captain and guide, has communicated an interesting observation of the apparent feeding of Rhineodon on sardines. In June some years ago, he was fishing for

marlin in the edge of the Gulf Stream off Turtle Rocks, near Bimini, Bahamas, when he saw a whale shark feeding along with tunas.

We were short of bait and ran over to a large school of small tuna that were striking bait on the surface of the sea, which was quite calm. Upon approaching the school, we saw a dark solid mass about 30 feet long by about 12 feet deep, through and around which the tuna were darting, and through which two or more sharks, some six or seven feet long, were swimming lazily. This compact mass was composed of millions of small black and silver sardines.

As the boat approached to within 8 or 10 feet of the sardines, the sharks and tuna left. I was handling the boat from the control on the top deck, and therefore had a clear view of what took place. I first saw the whale shark when he was about 20 feet down. He swam upward at an angle of about 20 degrees straight through the school of sardines. Turning far more quickly than I had thought such a huge fish could, he came back and once more swam through the sardines. As his huge bulk swept through the school, it had a tendency to scatter the bait on the surface of the sea. On his third trip through the school, the bait fishes were much spread out and were able to swim out of the big fish's way. He then turned off and settled down at once.

Capt. Gifford cannot say that he saw the great shark take sardines into its mouth nor did he see any dropping from its jaws. But he is unable to interpret the trips of the shark through the school as having any other purpose than that of feeding. However, this observation so closely parallels those previously set out and others to be found later herein, that it is to me a sound conclusion that like the tuna the whale shark was enjoying its favorite food.

There is now to be given here a brief account of the concentrated occurrence of the whale shark in the north-central Gulf of Mexico. The data came via the U. S. Hydrographic Office. Sixty-eight whale sharks had been seen from six steamers on eight trips in a rectangular area *c.* 120 x 170 miles or more narrowly within a circle having a radius of *c.* 87.5 miles. This concentration of ships is due to a converging of steamer lanes from Texas oil ports for the boats to swing around Florida in the Gulf Stream before straightening out on a northern course. This concentration of whale sharks can only be explained on the basis that there was here a great concentration of their food. What this food was cannot be said, since the ships were moving at from 12 to 16 knots, and while the officers saw the big fish and reported them, they could hardly have noticed any accompanying smaller fish—either tunas or sardines.

Whale Sharks and Tuna off Lower California

The whale shark has been recorded from the Gulf of Lower California since 1865. My accounts of its occurrence off the west coast of Lower California and around Cape San Lucas date from about 1925, and came from the reports of anglers fishing in those abundant waters. As time has gone on, anglers have more and more resorted to this region and they have reported many occurrences of our great shark. But the great development of tuna fishing all the way down the coast of the peninsula to and below Cape San Lucas has brought more accounts of the abundance of whale sharks, and of their association with the tunas. This phenomenon will now be set out fully and will throw a flood of light on other associations not clearly understood before.

My earliest knowledge of the association of whale sharks and tunas in this region came in a letter from Mr. Mack Sennett, the motion picture producer. In 1926, Mr. Sennett was fishing and also making submarine motion pictures of various fishes (including the whale shark) in the waters around Cape San Lucas and in the lower Gulf. In his letter, Mr. Sennett stated that he had found great numbers of tunas swimming about a 65-foot whale shark, and that about 20 were in close attendance on one shark when his boat came up to photograph it.

Mr. P. Nielsen of Nestor, California, wrote in June, 1937, that "The whale sharks are often seen in the summer months from Hipolito Point south. They're often found with a school of tuna, and fishermen will frequently stop and throw live bait overboard when a shark is sighted. This often results in tuna coming to the surface." Further correspondence with Mr. Nielsen brought, in September, 1937, this additional information. "The big spotted sharks will often circle the fishing vessels, while they are drift-fishing for tuna, and they frequently come within a few feet of the vessel. I've observed them eat the small fish used for bait—anchovies and sardines—when these are dead, but I have never seen one of these sharks catch a live one, and I believe that they are much too slow to do so."

Next comes valuable data kindly communicated by Capt. J. M. O'Niel, master of the fishing vessel "Pacific Queen" out of San Diego, California. He writes that:

> From April 9 to 14, 1939, we were fishing for tuna on Gorda Banks off the tip of Lower California, and each day we had at least one whale shark circling around us, under us, and everything but over us. We found that the tuna were always around these sharks, and that the sharks circled around our boat in order to eat the excess live bait that

we throw over to attract the tuna. Twice I had one of these whale sharks come alongside right under me, open its mouth in front of a small school of this bait and seem to exert a powerful suction, since the bait was drawn into the shark's mouth and he would swim on. Their movements are very slow and leisurely. These fish were 40 and 50 feet long. We became so accustomed to their cruising around us that they did not cause any interest after the first day or two.

Again under date of Sept. 1, 1939, Capt. O'Niel added these further interesting data on the feeding of our fish:

While fishing on the 100-fathom curve about 25 miles south and west of Cape San Lazaro, Lower California, on July 16 and 17, 1939, each day we sighted whale sharks, and, profiting by previous experience, we headed for them and when close aboard (say 20 or 30 feet) started throwing over live bait. The results were as previously experienced on Gorda Bank earlier this year, and we caught about five tons of yellow-fin tuna, which seemed to school up around the whale sharks. In appearance and action these sharks were exactly as described in my earlier report this year.

In this tuna fishing, to attract the tunas, live bait, the sardine (*Sardinia caerulea*), is used off Lower California. These sardines go in huge schools, are taken in large seines, are carefully transferred in dip nets to capacious tanks near the stern of the fishing vessel and these tanks are provided with a copious supply of fresh salt water. When a whale shark is sighted, the boat moves over and close up to the shark. Lowered over the rail aft are metal racks or stages on which the fishermen stand. They fish with heavy rods whose stout lines end each in a beardless feather-covered hook. When the fishermen reach a school of tuna, with or without an accompanying whale shark, the live bait is ladled overboard from the tanks. The ever-hungry tuna fight for the bait, but, as Mr. Nielsen and Capt. O'Niel state, the whale sharks not infrequently get their share. The technique of tuna fishing—with the whale shark unfortunately missing—has been admirably described and figured by John Tee-Van (1938). To his article the interested reader is referred.

The bait fishes, sardines and anchovies, are agile little fishes, and one could hardly expect the clumsy, slow-moving whale shark to catch individuals as such or as parts of a small school with its numbers somewhat scattered. On this point, recall Capt. Gifford's observation in the Bahamas. But these bait fishes go in enormous schools and off Lower Californian and Mexican coasts are fished for at night with a seine sometimes measuring 720 feet long and 72 feet deep. So large are the

schools and so closely packed are the fish, that sometimes the net is carried away by the weight and boats and men are endangered.

In the matter of the association of whale sharks and large fishes and of their mutual feeding on small fishes, it must be noted that the accounts cover a time interval of 60 years—from Günther (1880) to the present—and that they came from widely separated parts of the three central oceans. Furthermore, emphasis must be laid on the fact, that when multiple accounts come from certain restricted regions, as off Havana or Lower California, they were sent in by men who did not know that others were reporting from the same locality. Finally it must be re-emphasized that all accounts, from whatever ocean and source they have come, corroborate each other on all essential points—all dovetail together.

With these facts before him, the reader is prepared to believe that the whale shark feeds on such small fishes as go in schools, and that he can each time take in a large mouthful. Easy then is it to understand the association of whale sharks and tunas—they are feeding together on sardines in the Bahamas and off the west coast of Lower California. And so are bonitos and whale sharks off Havana, Cuba. This too explains the association of whale sharks and bonito off Hondo, Japan, and of whale sharks and the carangid fish at the Seychelles.

How Rhineodon Takes in the Sardines

This is so simple that it hardly needs to be categorically set out. Yet, for completeness and to emphasize the process, it will be done. It is greatly to be regretted that no photograph has ever been made of Rhineodon in the act of feeding on sardines, and that no one has been able to dissect a whale shark and find large numbers of sardines and other small fish in its stomach. Some day both these objectives will be attained and then the case will be closed.

The method of in-taking of invertebrate food has been figured and described. The great shark swims with slightly open mouth at the surface of the sea. Water enters by the mouth and passes through the sieve-like gill arches leaving behind all except the smallest organisms. The foodstuff passes down the throat, while the water, coursing through the sub-gill-arch cavities, passes into the sea through the gill slits. Probably the largest amount of food materials thus gathered consists of swimming crabs and small squids.

The in-taking of vertebrate food is considerably different. It has been described by various men. Two have described the catching of sardines by Rhineodon off Havana and off Manzanillo, Cuba. One reported that he had seen the big shark feeding on sardines, filling his mouth full and then swallowing them. Here, unfortunately there is a painful lack of details. Another had seen the great shark standing vertically in a school of sardines and apparently letting the small fish jump into its mouth. Then there is Dr. Cardenas's statement from his fishermen that the whale shark stands vertically in schools of bonito which jump into the whale shark's mouth while pursuing sardines. My explanation of this alleged feeding has been given elsewhere and need not be repeated here.

A very accurate description and the simplest explanation of the taking in of sardines is given by Capt. O'Niel. In describing the throwing over of bait to attract tuna off the coast of Lower California, he stated that the shark as well as the tuna would come near the boat to feed. Then the great shark would "open its mouth in front of a small school of bait and would seem to exert a powerful suction since the bait would be drawn into his mouth and he would then swim on." Presumably this is just what Rhineodon does when he approaches a free school of sardines out in the sea. This is the way in which any large fish takes in food made up of relatively small fishes, i.e., thus the wide-mouthed angler, *Lophius*, takes in small fish, several or one at a time.

Since the above was written there has come, via the U. S. Hydrographic Office, some exceedingly valuable corroborating data. Capt. R. W. Mindte of San Diego writes that it is well known that whenever a whale shark is sighted it will be surrounded by yellow-fin tuna, and the fishermen head for it at once. Then he gives the following definite evidence—first (the only account for California waters) that the fish stands vertically in the water, and second that it feeds by suction. He states that:

> Often these sharks appear to be floating tail down in a vertical position in the water with the mouth submerged about one foot in the water. On one occasion while throwing live bait overboard, we noticed that any bait that fell within 3 or 4 feet of the shark's mouth was sucked in by a tremendous suction. We could even see the bait trying to swim away from the mouth, but the pressure was too great. The shark's mouth at this time opens vertically about eight or ten inches.

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ANNUAL REPRODUCTIVE CYCLE OF THE MALE FENCE LIZARD

By Paul D. Altland

Plate 2

INTRODUCTION

In lizards, as in other animals that mate but once each year, there are seasonal variations in the size and microscopic structure of the testis. It has been demonstrated that various members of the Lacertilia show different types of reproductive cycles. Herlant ('33), and Regamey ('35) find that lizards of the genus Lacerta begin spermatogenesis in late summer and spermiogenesis in March, and that the breeding season in May is followed by a period of involution, which is completed by August. In an experimental study on *Eumeces laticeps*, Turner ('35) reports that control animals show spermatozoa in April, breed in May, and pass through a season of low sexuality from October to December. Another type of cycle is found by Blount ('29) in the horned toad (*Phyrnosoma cornutum*), in which spermatogenesis begins in May and ends during the breeding season in mid-August, after which the testis remains in a quiescent state until spring.

During the course of an investigation on the relationship of the hypophysis and testis of the fence lizard, *Sceloporus undulatus*, it was found that the annual reproductive cycle is unlike that found in the other North American lizards studied (Eumeces and Phyrnosoma). Since it seems desirable to make this information available, a complete account of the weight of the testis in each month of the year, and an analysis of the microscopic structure is given.

MATERIALS AND METHODS

The fence lizards, *Sceloporus undulatus undulatus* (Latreille), were collected in the Duke Forest, Durham, North Carolina. During October a large number of specimens were caught, housed in out door cages, and fed upon meal worms and fly larvae. With the approach of winter the lizards hibernated under the leaves and twigs in the con-

tainers. In this manner a source of lizards was maintained during December, January, and February. This phase of the work was carried out in the zoological laboratories of Duke University, Durham, North Carolina.

Differences in the size of the right and the left testes were noted, but the variation was so slight and inconsistent that it was not considered to be of any particular concern. Both testes were removed: one was preserved in Bouin's fluid, carried to 70% alcohol, and weighed; the other was fixed in Allen's modification of Bouin's fluid for a study of the cytology of the testis. All tissue was embedded in paraffin and cut at 6 and 8 microns. Some of the tissues were stained with Ehrlich's hematoxylin and counterstained with eosin; others were stained with Heidenhain's iron hematoxylin followed by 1% phosphomolybdic acid and methyl green.

In making the table of the gonadal weights and the diameters of the seminiferous tubules, animals were chosen to represent regular intervals throughout each month. The body weights given for all lizards are the actual live weights.

OBSERVATIONS

The testis of the adult fence lizard is an ovoidal organ when observed intact in the animal, but after removal it becomes almost spherical. Its light color is maintained throughout the year. The left testis lies just anterior to the kidney, and the posterior margin of the right testis begins near the anterior limit of the left. The testes are suspended in the body cavity by mesorchia which are attached to the pigmented peritoneum. The connective tissue surrounding the testis, the tunica albuginea, is continuous with the fibrous tissue found between the seminiferous tubules. This connective tissue is very thin when the organ is enlarged, and as the testis decreases in size during the regressive stages of the cycle, this fibrous cover becomes thicker (figs. 1 and 5). The mesothelium surrounding the connective tissue does not undergo any change during the enlargement.

A compact gland, associated with the adrenal complex of the fence lizard, lies dorsal to the testis and is enmeshed in the supporting tissue. From July to April a fat body is found associated with the testis; its yellow color stands out clearly against the black peritoneal background. The size of this fat body is greatest from August until October; after this period it gradually decreases in size until it completely disappears some time after emergence from hibernation. An account of the uro-

genital system will not be presented at this time, but will be considered in relation to some experimental work in progress.

The arrangement of the seminiferous tubules is very irregular, only a few tubules in a transverse section through the gland being cut in a complete cross section. The seasonal alteration in the size and microscopic structure of the testis is very pronounced in the fence lizard. Spermatogonial divisions are abundant in July and August, but are encountered less frequently in September, October, and November. Spermatogenesis begins in August, with an increase in the size of the spermatogonia and the appearance of the process of synapsis. During September and October the primary spermatocytes with conspicuous pachytene, diplotene, and diakinetic stages, occupy over half of the tubular diameter. Secondary spermatocytes and spermatids are forming a complete layer around the lumina of the tubules. Spermatozoa are not usually found, although occasionally small groups of ripe spermatozoa appear in these autumn testes. The nuclei of the Sertoli cells are scattered here and there along the basement membrane, and they are differentiated from the surrounding spermatogonial nuclei by a lighter staining chromatin material. Very little intertubular space is present, but blood vessels, endothelial nuclei, and fibrous connective tissue may be identified. Interstitial cells have not been observed (fig. 1).

The onset of spermatogenesis is marked by a general increase in the weight of the testis and in the size of the seminiferous tubules. During the period of rest in July the average weight of the testis is 16 milligrams, which is the lowest weight recorded throughout the yearly cycle. The diameter of the seminiferous tubules is smallest in July, measuring approximately 110 micra. In August the average weight increases to 51 milligrams. During September and October there is considerable variation in testis weight, this being due to the action of the new spermatogenic cycle. In view of this evidence it seems that some testes respond more readily than others to the stimuli initiating testicular activity.

During November there is a change in the predominating cells in the tubules. Instead of the primary spermatocytes being most numerous, as they are in September and October, the secondary spermatocytes and spermatids are now most abundant (fig. 2). Ordinarily there are no spermatozoa present. In November the average weight of the testis is 278 milligrams, the highest average for any month throughout the annual cycle. A testis weighing 297 milligrams was taken from an animal on April 2nd. Scattered groups of spermatozoa were observed

in each tubule, and a predominance of spermatocytes and spermatids was evident, a condition typically found in January and February.

Evidence of the normal appearance of spermiogenesis is encountered in December, and as a result small clusters of ripe spermatozoa are associated with the secondary spermatocytes and spermatids in every tubule. It is very difficult to detect Sertoli cells in these enlarging tubules. Metamorphosis of the spermatids continues slowly during January and February, and spermatozoa soon completely line the lumina of the tubules (fig. 3). Spermatogonial divisions are of rare occurrence in the hibernating season.

TABLE 1

All data have been obtained from adult male lizards weighing between 9.2 and 9.8 grams.

MONTH	NUMBER OF ANIMALS	WEIGHT OF THE TESTIS IN MILLIGRAMS			DIAMETERS OF THE SEMINIFEROUS TUBULES IN MICRA		
		Min.	Ave.	Max.	Min.	Ave.	Max.
January	7	170	215	288	261	275	294
February	7	160	195	210	251	261	302
March	7	115	165	252	232	257	278
April	20	115	135	297	220	232	249
May	16	60	91	110	180	204	215
June	12	52	56	61	142	153	175
July	9	14	16	25	107	110	131
August	10	29	51	69	109	145	170
September	11	48	92	185	119	160	197
October	15	220	232	248	261	286	318
November	10	261	278	298	262	293	320
December	5	220	240	275	225	285	312

In March, April, and May a marked change in the nature of the testis is noted. There is a gross transformation of spermatids to form spermatozoa, but in figures 4, 5, and 6 it is clearly shown that not all of the spermatids mature at this same time. Masses of spermatozoa line the lumina of the tubules, becoming so numerous that an association of spermatozoa with the Sertoli elements has not been clearly demonstrated (fig. 4). However, the central location of Sertoli cells in July and August suggests that they may have been present in May also, but they were apparently obscured by other cells. In May spermatogonial divisions are found only rarely. Despite the continued activity of the primary spermatocytes, the enlarged cord size is not maintained;

this is due in part, at least, to the large quantities of spermatozoa that are transferred to the epididymis and vas deferens, which are highly developed at this time. The sexual segment of the kidney and the femoral organs are also greatly enlarged during this period of high sexual activity. The average weight of the testis continues to be reduced until in May it is only 91 milligrams; during this same period the average diameter of the seminiferous tubules is reduced to 204 micra.

Copulation has been observed in May and early June. After the breeding season many spermatozoa still remain in the testis and ducts (figs. 5 and 6). Except for a layer of spermatogonia along the basement membrane, almost the entire cellular structure in many tubules has disappeared by July. There is no evidence of degeneration of spermatogonia; in fact, mitoses are very abundant, apparently building up the germinal epithelium for the next cycle. The lumen appears quite large when compared with the area occupied by the cellular elements. Occasionally a few scattered spermatozoa surrounded by material sloughed off during the maturation process may be found in the lumen, and some primary spermatocytes are also a part of the remaining cellular structure.

In June and July the Sertoli cells are scattered among the spermatogonia next to the basement membrane, and occasionally they are found in the center of the tubules. The Sertoli cells are spherical and well-defined, instead of being compressed by adjoining cells, as is the case from September to June. The cell membrane of these cells stands out sharply. It is characteristic to find an ovoidal mass very closely associated with the large spherical nucleus. Although the testes were not prepared to demonstrate cytoplasmic inclusions, it appears as if this material corresponds to the fatty inclusions described by Herlant ('33) and Regamey ('35) in the Sertoli cells of Lacerta. Mitoses have not been observed in the Sertoli cells.

In August the seminiferous tubules are dominated by resting spermatogonia, although mitotic stages are quite numerous. There is no lumen present, the central portion of the tubules being filled with cells, some primary spermatocytes probably remaining from the previous cycle, and others beginning the new (fig. 7). Apparently all of the spermatozoa that were not released in the breeding season have been completely destroyed by this time. An examination of the intertubular areas indicates that there are no interstitial cells present. Well-defined interstitial cells have been found in the testis of the blue-tailed skink,

Eumeces fasciatus, by using the same methods employed in the preparation of the fence lizard material.

In males weighing from 3 to 8 grams the seminiferous tubules are usually small from April until August. The testis weight of such specimens varies from 10 to 30 milligrams. The gland is in an immature condition, showing one or two layers of spermatogonia, scattered Sertoli cells, and no perceptible lumen.

DISCUSSION

The testis of *Sceloporus undulatus* has one sexual cycle during the year. Spermatogenesis begins in August and continues until July. During the first three months of growth primary spermatocytes, secondary spermatocytes, and spermatids are formed in great numbers. Spermiogenesis begins in December, and by April the seminiferous tubules contain many spermatozoa. The breeding season occurs in May and early June, after which there is a period of involution and rest before the onset of the next cycle. In the course of this activity there is wide variation in testis size. In late July the testis is very small, growing to the maximum size in about three months, and from this time until the end of the yearly cycle there is a gradual diminution in size.

The spermatogenic cycle of *Lacerta muralis* and *Lacerta serpa*, as reported by Regamey ('35), are essentially the same as that given for *Sceloporus undulatus*, although there are some minor variations. At the beginning of August, when the seminiferous tubules of the fence lizard are largely taken up by spermatogonia, a few normal primary spermatocytes are found. One cannot be certain whether maturing cells still remain from the last cycle or not, but there is such a great development of primary spermatocytes in September that they probably represent the first of the new series. In Lacerta Herlant ('33) finds dividing primary spermatocytes in July, and spermatids in August, which he apparently considers to be a part of the new cycle. From December through the remainder of the cycle the testis of the fence lizard shows a gradual reduction in the diameter of the seminiferous tubules, while in Lacerta the tubules do not begin to decrease in diameter until the end of March. In both cases the decrease in the tubule size is correlated with spermiogenesis and the release of spermatozoa. The spermatozoa that occur in October and November are probably stimulated by some unseasonal factor, and their presence is not associated with a false breeding season, as has been reported for the musk turtle (Risley, '38) and the

salamander, *Triturus viridescens* (Adams, '40). Regamey ('35) considers this autumnal spermiogenesis to be abortive and of little importance in *Lacerta agilis*. The normal spermiogenesis occurs in the spring.

Forbes ('41) reported that in *Sceloporus spinosus floridanus*, which were kept in the laboratory at room temperature, the testis showed spermatogenesis resembling the full breeding condition at the end of March. He considered it likely that active spermatogenesis begins after February 15th. Turner ('35), working with *Eumeces laticeps*, and Clausen and Poris ('37), with *Anolis carolinensis*, found that the breeding season occurs in the spring and that the testis is relatively inactive during the winter. Although these workers were not concerned with the complete annual cycle, it is apparent from an analysis of their work, that active spermatogenesis does not occur until early spring. In *Sceloporus undulatus* maturation divisions are prominent as early as September. Blount ('29) in a study of the testis of the horned toad, *Phyrnosoma solare*, found that spermatogenesis appears first in May and then proceeds rapidly, with mature sperm occurring within several weeks. The height of spermatogenesis is in mid-July, with breeding activity prevalent about the 15th of August. Among lizards this is the only instance, so far as the author is aware, of normal breeding occurring at any other time than the period following the spring awakening. According to Risley ('38) the musk turtle, *Sternotherus odoratus*, begins spermatogenesis in May, and by September or early October the tubules are filled with sperm. A false breeding season may occur in the fall, but normally sexual relations take place about the middle of May. It has been noted that the seasonal variation in the quantity of the spermatic tissue given by Oslund ('28) for *Bufo vulgaris* and *Rana temporaria* very closely resembles that found in Sceloporus.

During June and July the spherical Sertoli cells are much more conspicuous than when they are elongated due to compression by adjoining cells. Turner ('35) also noted that the Sertoli cells of the testis of *Eumeces laticeps* were brought into greater prominence through the atrophy and aplasia of the cells of the previous reproductive cycle. In the work of Risley ('38) on the musk turtle it has been found that after the liberation of spermatozoa in June, the entire lumen of the seminiferous tubules fills with the cytoplasm of the Sertoli cells. After emergence from hibernation, when the tubules are filled with spermatozoa, the Sertoli nuclei are located well out toward the center of the tubule, away from the basement membrane, and they outnumber the

spermatogonial nuclei in a ratio of 6 or 8 to 1. In Sceloporus the Sertoli cell nuclei have not been found to outnumber the spermatogonial nuclei.

It has been reported by Herlant ('33) in *Lacerta muralis*, and Risley ('38) in the musk turtle, that when these animals are kept under laboratory conditions, they show active spermatogenesis in the winter. The fence lizards were kept in an environment very similar to the natural winter conditions, and they gave every indication of hibernating in the normal fashion. If the spermatogenic and spermiogenic activity observed in the fence lizard during the winter sleep is a part of the normal cycle, then it is suggested that darkness and low temperature do not inhibit testis activity in the fence lizard. Riley ('37) found that spermatogenic activity occurred in the house sparrow during a period of darkness, although he also found that the annual sexual cycle may be stimulated by light. Clausen and Poris ('37) discovered that the winter testis of *Anolis carolinensis* gave no indication of spermiogenesis. They were able to show that 6 hours of added illumination daily caused the seminiferous tubules to increase nearly twice their size and also stimulated the testis to such a degree that all the stages of spermatogenesis were produced, including numerous ripe spermatozoa. Apparently the inherent spermatogenic cycle may be influenced by an environmental factor such as light; therefore, it is not at all surprising to find an increase in the spermiogenic action upon emergence from hibernation, since the animals are then exposed to an increase in light, temperature, and an abundance of food.

In searching for factors controlling the testis cycle one ordinarily turns to the anterior hypophysis. Evans ('35a and '35b) has demonstrated that sheep pituitary extract and Antuitrin-S have a stimulating effect upon the reproductive system of *Anolis carolinensis*. The testis of *Eumeces laticeps*, according to Turner ('35), responded to injections of anterior pituitary-like substances from pregnancy urine during the season of lowest sexuality, by showing 148% increase in weight and the production of ripe spermatozoa. Mellish ('36) has subjected sexually inactive horned lizards, *Phyrnosoma cornutum*, to an increase in temperature and injections of hog pituitary extract, and found a stimulation of the testis comparable with that normally appearing in the breeding season. He suggests that the anterior pituitary may have an inherent cycle, and that the action of the testis may be the result of the anterior pituitary products being liberated and used at a time when environmental conditions are favorable. That the anterior hypophysis is

related to the reproductive cycle in the fence lizard has also been suggested by structural alterations that appear in the anterior lobe during the breeding season (Altland, '39).

It is of significance that no interstitial cells have been demonstrated in the testis of the fence lizard at any time throughout the year. No mention was made of interstitial cells in the testis of *Anolis carolinensis* by Evans and Clapp ('40) in their study of the effect of ovarian hormones and seasons on the testis. In all other members of the Lacertilia that have been studied thus far, interstitial cells have been described. In Lacerta, according to Herlant ('33) and Regamey ('35), the secondary sexual characters, such as the epididymis, the vas deferens, the sexual segment of the kidney, and the femoral organs, are at their maximal activity in May, at the time when the interstitial cells are best developed. In the horned toad, as reported by Blount ('29), interstitial cell development is closely correlated with the germinal cycle, the volume of interstitial material and the size of the individual cells being greatest during the breeding season. Turner ('35) mentions the presence of interstitial cells in the testis of *Eumeces laticeps*. Risley ('38) found interstitial cells with large rounded nuclei at all times during the year in the musk turtle, but he did not observe any seasonal fluctuations. Even though no interstitial cells were found in the fence lizard, the secondary sexual characters are very well developed during the breeding season.

SUMMARY AND CONCLUSIONS

Adult fence lizards were collected in the Duke Forest, Durham, North Carolina. The testes were preserved and weighed during every month of the year. A table showing the weights of the testes and size of the seminiferous tubules was constructed. An analysis of the testis weight and microscopic structure shows that spermatogenesis begins in August.

The testis is smallest in July, just before the onset of the reproductive cycle. Primary and secondary spermatocytes and spermatids gradually increase in number during a period of very active growth in September, October, and November. The testis reaches its maximum weight by November, at which time it is approximately 17 times as great as before the onset of spermatogenesis. There is a gradual transformation of spermatids to form spermatozoa during December, January, and February, and then in March and April spermiogenesis increases in intensity. The breeding season starts in May and continues for a period of approximately five weeks. Although maturation divisions are still prevalent in

July, the testis is undergoing degeneration, except for the spermatogonia which are actively dividing in preparation of the next cycle. Involution is completed by the end of July. From November until June there is a gradual decrease in the size of the testis, with the greatest reduction occurring after March. This reproductive cycle of the fence lizard is very similar to that described for lizards of the Genus Lacerta.

No interstitial cells have been demonstrated in the testis; in fact, at all times throughout the year there is very little intertubular space. The secondary sexual characteristics show seasonal alterations, with the maximum development during the breeding season.

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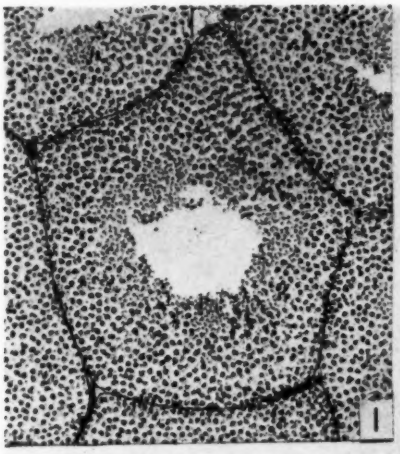
PLATE 2

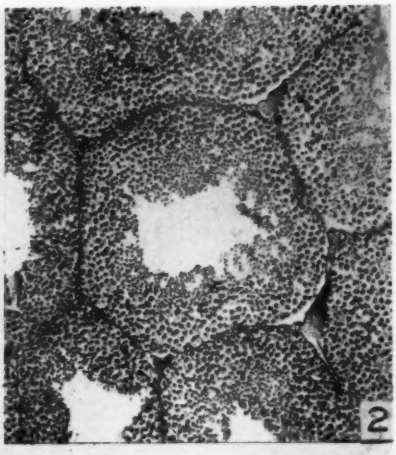
EXPLANATION OF FIGURES

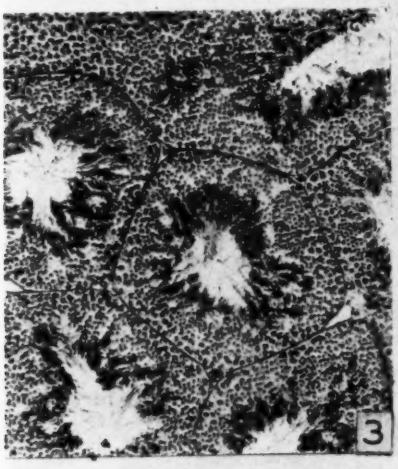
All figures were made from photomicrographs on Wratten M plates. A 16 mm. apochromatic objective, N.A.O. 30 and a compensating ocular 10 × were used. The magnification given represents the original magnification, which has been reduced one-third in reproduction. The photomicrographs were taken from material stained with iron hematoxylin and methyl green with the aid of a Wratten filter E22.

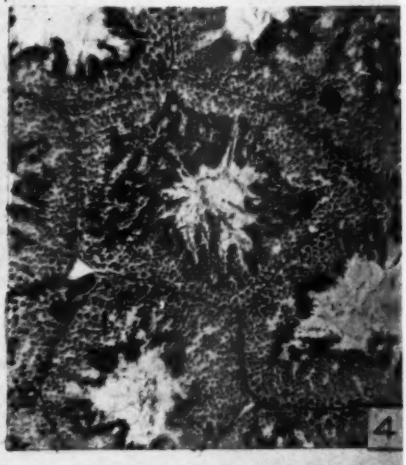
1. Section through the testis of a lizard preserved October 15th. Over half of the cells of the enlarged seminiferous tubule are primary spermatocytes in stages of division. Secondary spermatocytes and a few spermatids are also shown, but there are no spermatozoa present. There is very little intertubular space. × 200.
2. Transverse section of a portion of the testis preserved November 23rd. The secondary spermatocytes and spermatids are quite numerous, but mature spermatozoa are not found. Although this tubule is smaller than the one in figure 1, the average diameter is greater in November. × 200.
3. Section through the testis taken March 15. Spermatogenesis is clearly shown. Large numbers of mature spermatozoa have accumulated around the edge of the lumen. × 200.
4. Great masses of ripe spermatozoa are shown in the testis April 25th. It is difficult to observe the relationship the Sertoli cells have to such large quantities of spermatozoa. There are no interstitial cells present. × 200.
5. A portion of several tubules of a testis preserved June 10th. Spermatogenesis and spermiogenesis are still clearly shown. The connective tissue between the tubules is somewhat heavier than that shown in figure 4. The large Sertoli cells may be observed along the basement membrane. × 200.
6. Seminiferous tubules of a testis preserved July 10th. Although mature spermatozoa are still found, it is quite evident that there is a regression of the cellular elements. Along one tubule it is shown that the germinal contents have been reduced to a single layer of cells. Spermatogonial divisions are present. × 200.
7. Several seminiferous tubules of a testis taken August 4th. The involution of the seminiferous tubule has been completed. Spermatogonia are very numerous. It is apparent when a comparison of figures 1 through 7 is made that there is a marked change in the size and microscopic structure of the testis of the fence lizard. × 200.

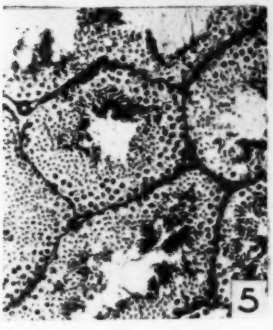
PLATE 2

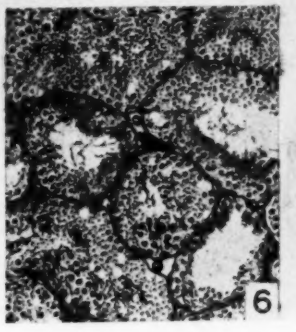


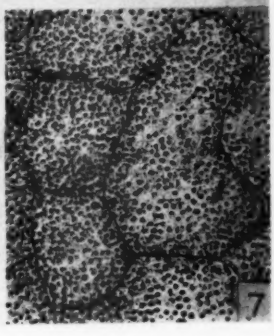












CRETINOID PROGENY FROM HYPERTHYROIDIZED RATS

By Bert Cunningham

One Text Figure

For a number of years, through experimentation in the zoölogical laboratories of Duke University, we have been aware of the fact that hyperthyroidization of pregnant rats produced cretinoid offspring. In experiments conducted as early as 1928 with the aid of Mr. W. A. Ellison and a year or two later with the aid of Miss Dorothy Schallert cretinoid young rats were produced. The variability of the results precluded publication at that time. In these early experiments a few of the normal offspring approached a lower weight comparable to that of experimental animals, while a few of the experimentals appeared to be nearly as heavy as normals. The average weight of experimental animals, however, was considerably below that of the normals. Later work has lead us to believe that these results were consistent and compatible with a reasonable theory.

In any effort to approach the study of the production of cretinism by experimental methods it is necessary to keep in mind that there may be two types of cretinism due to thyroid deficiency, namely, (1) that kind which is due to the genetic make up of the parents, and (2) that type which is due to the improper development of the thyroid gland due to causes other than genetic. In this study the interest centers around the second type.

It has been thought for a long time that animals with defective thyroids might pass on this condition to their descendants. Such conditions have been reported from time to time in the literature. Where such transmission occurs it may be assumed that it is genetic. On the other hand one would hardly expect that the removal of the thyroid from a normal female would affect the normal development of her offspring if after the operation she could and would breed. Apparently a number of workers have been unable to get progeny from thyroidectomized animals, but our experience on that question will be the basis of a later paper. Neither would one expect to change the course of nature in the embryos by hyperthyroidization of the mother.

The term cretin covers rather a wide scope since it ranges from "complete cretinism" to only a slight manifestation of the condition. There are a number of criteria which may be used in determining cretinism although it would be difficult to limit exactly the term or draw a distinct line between cretin and noncretin. In rats such factors as metabolic rate, heart rate, condition of coat, development of bones, and growth rate may be considered as criteria, as may also a histological study of the thyroid gland.

Through the kindness of Dr. M. O. Lee the basal metabolic rates (B. M. Rs.) of some of the rats from earlier experiments were determined. The rats selected were the most nearly normal in weight of our experimental animals, but their B.M.Rs. were consistently about 20% below

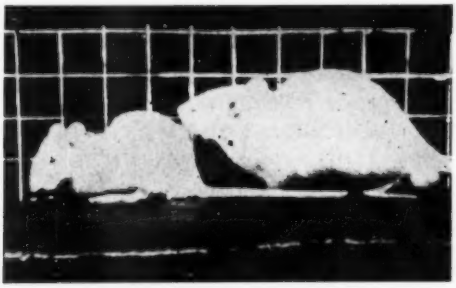


FIG. 1. (a) Photograph of a cretinoid rat. (b) Photograph of a normal rat. Both 68 days old.

normal rats of similar weight from the same colony. Their heart rates were also lower.

Histological study of the thyroid involves the determination of follicular volumes as well as the volume of secretory cells. Such studies were made and the experimental animals showed a considerably reduced gross size of the thyroid, accompanied by a reduction of total follicular volume and total volume of secreting cells.

Three years ago with the aid of Mr. Fred Ketchum a rather large colony of experimental and control rats was set up, and the growth rates determined. Results concordant with earlier experiments were secured. For comparison purposes Figure 1 shows the largest cretinoid rat (a) and the largest normal rat (b) at 68 days.

The voluminous data of the earlier work are not incorporated in this paper as they are in agreement with the findings of our latest experi-

ments, the data of which are given here. The latter will serve as an example of the findings in the earlier work.

Since various experimental individuals have shown one or another of these criteria always associated with the reduced growth rate, and although no single individual has been examined for all the criteria, it is assumed that animals born of hyperthyroidized mothers which exhibit the retardation of growth are cretinoid in nature. It is also assumed that the degree of retardation of growth indicates somewhat the degree of the cretinoid condition. This is evidenced by the greater retardation of heart rate, and the lowered metabolic rate in the less rapidly growing animals among those from treated mothers.

It can be legitimately objected that the cretinism is not necessarily produced by hyperthyroidization of the mother. A critical test of

TABLE I

Average Weights of Normal and Cretinoid Rats Post natal to Weaning

	CONTROL				EXPERIMENTAL			
	No.	Av. Wt.	Max.	Min.	No.	Av. Wt.	Max.	Min.
Birth	42	5.78	6.7	4.8	65	5.03	6.2	4.2
7 days	42	11.5	15.0	7.5	63	10.2	13.1	6.2
14 days	42	17.6	25.0	12.1	61	15.8	22.0	10.5
21 days	39	26.4	38.0	20.8	49	22.0	28.0	16.5

whether or not the hyper condition of the mother has hampered the development of the foetal thyroid would lie in the growth rate response of the young experimental animals to thyroid medication.

With this test in mind the following experiments were carried out with the aid of Mrs. Sarah Harris.

Two female rats were mated to a male in each experiment. One of the females received daily doses of 10 mg. of desiccated thyroid tissue preceding and during pregnancy and through nursing. The other served as a control. The females were isolated at near term and the young weighed within 24 hours after birth. They were also weighed at 7, 14, 21, 30, 60, 90, and 120 days after birth.

At birth there was a little better than 10% difference in the average weight of the young. This differential was maintained until a few days before weaning but at weaning it had reached about 20%. The difference of maximum weights at weaning was about 30%. The complete data are shown in Table I.

Between 14 days and weaning (21 days) there was a very high death rate in the experimental group, for which no definite cause could be found.

At weaning the cretinoid animals were divided into two groups, one of which received 10 mg. of desiccated thyroid tissue per animal daily with its food, the other was untreated. The data are presented in Table II.

At 60 days the thyroid treated animals overtook the normals in weight and maintained this position past 120 days. The data in Table II include the 120 days weights but since the cretinoid group had been reduced by death to about half, those remaining at that time are not thought to be sufficient in number to consider as conclusive evidence.

TABLE II

Average Weights of Normal, Cretinoid, and Cretinoid plus Thyroid from Weaning to 120 Days

	NORMAL				CRETINOID				CRETINOID + THYROID			
	No.	Av. Wt.	Max.	Min.	No.	Av. Wt.	Max.	Min.	No.	Av. Wt.	Max.	Min.
21 days	39	26.4	38.0	20.8	27	21.5	27.0	16.8	22	22.7	30.5	16.5
30 days	36	39.6	55.0	30.0	21	29.2	39.5	21.0	17	30.3	44.10	22.0
45 days	34	74.9	105.0	44.0	21	60.0	85.0	29.0	16	63.4	89.0	41.0
60 days	34	105.6	143.0	63.0	21	93.5	135.0	49.0	15	105.4	146.0	82.0
90 days	28	167.3	214.0	122.0	20	143.5	170.0	111.0	15	170.0	239.0	131.0
120 days	22	191.0	236.0	142.0	8*	176.0	218.0	148.0	7*	194.0	239.0	146.0

* The data for these are thought not to be significant.

From these data it is apparent that some cretinoid animals (based upon growth rate) occur in the normal stock. This is to be expected. It is also to be noted that among the experimental offspring there are some maximal growth rate animals that approach the normal. These latter can probably be accounted for by the variable response to medication of the treated animals and by the individual foetal response to the thyroid content of the maternal blood stream. Nevertheless when one considers the whole picture it is evident that the hyperthyroidized mother tends to produce cretinoid offspring by affecting in some manner the development of the foetal thyroid. That the effect is upon the thyroid is evidenced by histological study, basal metabolism studies and by the effect of replacement therapy, which seems to compensate completely for the defect.

Other studies* with Mr. G. W. Morrison on the learning ability of normal rats, of cretinoid rats, and cretinoid rats treated with thyroid add additional evidence to the conception that the young are really cretinoid but in variable degrees. These findings seem to agree rather well with the earlier observations of Gudernatsch (1915 and 1933) who by massive doses hyperthyroidized breeding rats. During extreme hyperthyroidization the rats failed to become pregnant. About three months after treatment ceased, the females became pregnant but later gave birth to abnormally small, short-lived young. Fortunately, the dosage used in the present experiments was large enough to be effective, but not large enough to be sterilizing. Gudernatsch used fresh bovine thyroid. Calculated in terms of the desiccated thyroid used in these experiments his dosage was about 2½ times as much as the daily dosage in these experiments. Schallert's data indicate that even at 10 mg. daily some animals become sterile. One rat that was pregnant when feeding was begun delivered a litter after 14 days feeding and then remained sterile for 118 days, at which time the experiment was discontinued. Another remained sterile for 165 days after which she produced a litter. The sterilizing effect was even more marked when both parents received thyroid. Fifteen females were mated to six males and both were given 10 mg. daily doses. With the exception of one pair all matings were sterile for periods varying from 62 to 138 days at which time the experiments were discontinued. One female gave birth to a litter on the 49th day, and another litter on the 112th. The 10 mg. dosage must be near the maximum at which fertility may be retained, especially after protracted treatment.

Schallert mated 13 females with 7 males and gave them 20 mg. desiccated thyroid daily. One animal was fertile at 11 days, and was removed from the experiment. Another, being pregnant when the experiment was started littered on the 16th day of feeding. She remained sterile thereafter to the close of the experiment. When the experiment was closed, ten of these mating had remained sterile for 61 days, one for 96, one for 97, and one for 112 days.

Apparently when Gudernatsch's animals reached a level of hyperthyroidization somewhat above that induced by 10 mg. daily doses they became pregnant and produced cretinoid offspring. Possibly a slightly higher dosage in these experiments would have given a higher incidence and a more pronounced cretinism in the offspring.

* In Press.

SUMMARY

Studies over a considerable period of time indicate that hyperthyroidized female rats tend to produce cretinoid offspring. The more recent experiments, involving 65 young from such mothers and 42 normal young, show that the growth rate of the former is significantly less than that of the latter. Earlier studies (not published) showed the cretinoid young to have a lower metabolic rate, and a slower heart rate. The offspring of hyperthyroidized mothers also showed a reduced gross size of the thyroid as well as reduced follicular volume and secreting cell volume. In the present series of experiments it was found that the cretinoid condition (so far as growth rate is concerned) can be overcome by thyroid medication which lends further support to the theory that the thyroid gland of the foetus has been affected by the hyperthyroid condition of the mother.

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FAUNA OF PINE BARK

By Helen Ramsey

Bark of trees offers a satisfactory environment for a variety of animals. Some are characteristic of that habitat, others are present only accidentally. The crevices and tunnels in bark provide shelter for many. Food is available for both herbivorous and carnivorous species. Animals from the litter on forest floors often migrate up tree trunks to seek food or to avoid excessive moisture. An extreme example of this is that reported by Annadale (1907) in India, where earthworms migrate up tree trunks during periods of heavy rainfall and during the night when the humidity is high. Felt (1905–1906) in his report on insects associated with park and woodland trees mentions sawflies, cynipids, cecidiomyids, boring beetles, chrysomelids, curculionids, scotylids, lepidopters, aphids, and scale insects. Those that usually feed on pines were said to be bark-borers, ambrosia beetles, and leaf feeders.

Ecological surveys of wooded areas rarely take into consideration animals present in bark, as most of these are located deep in crevices or bore in the wood. Animals in the bark of fallen trees have been studied by Graham (1922), Adams (1915), and Savely (1939). This fauna resembles that of litter more closely than that of the bark of standing trees, particularly after the first year that a log has lain on the ground.

This paper presents the results of a survey of the fauna inhabiting the bark of the loblolly pine, *Pinus taeda* Linn. and of the shortleaf pine, *Pinus echinata* Mill. Collections were made in the Duke Forest, Durham, North Carolina, during the summer of 1937 by Gladys Mitchell, and from February, 1939, to December, 1940, by the writer with the help of Dr. A. S. Pearse. Bark from a total of forty-nine trees in a variety of situations and at all seasons was examined. Samples consisting of square-foot areas were removed at each of three successive levels on the tree trunks; these levels were 3–15 inches, 15–27 inches, and 27–39 inches above the ground, respectively. Collections were rotated in such a way that the total areas from north, south, east, and west sides of the trees were equal. Each sample was collected and sorted on a large sheet and the animals from it preserved for identification. No attempt was made to collect specimens of microscopic size. Briscoe (1940) has

shown that such organisms may be abundant in bark. Furthermore, many Collembola and other minute animals were doubtless overlooked because of their small size or because they escaped before they could be captured.

A list of the species of animals found in pine bark is included at the end of this paper. In all 1479 specimens were collected, an average of 10.1 animals per square foot of bark. They represent both adult and immature stages of 137 identified species as follows: insects, 78; spiders, 48; centipedes, 6; phalangid, 1; snail, 1; and mites, 3; as well as several minute unidentified insects. Ants outnumbered other animals; large colonies were often found tunneling under the bark. Spiders also were always present; excluding ants more were collected than all insects combined. Many of the immature stages found represented species not regularly found in pine bark in the adult stage—stiletto flies, sawflies, ichneumon flies, grasshoppers, and lepidopters. There were also developmental stages of types commonly found in bark as adults; these included cockroaches, elaterids, etc.

Animals, particularly spiders, were most abundant in the bark of trees situated in regions of dense underbrush; other than this the situation seemed to have no bearing on the fauna of bark. Collections from various levels above the ground yielded somewhat different results (Table 1). In general the greatest number of animals was found near the base of a tree. The total number of specimens taken from the first square foot above the ground was 600; from the second, 457; and from the highest level, 422. Variations in respect to this distribution occurred among different species. Those animals which migrated up from the litter were naturally more abundant near the base of a tree; for example phalangids, snails, in some cases spiders, and particularly centipedes. Centipedes showed further specific differences among themselves; most were found near the ground, but Scolopendra was almost always at higher levels. At the other extreme were insects such as flies and wasps, which were apparently random visitors that had arrived by air and were usually found at higher levels on the tree trunk. The permanent residents such as ants, many beetles, mites, and most spiders were distributed rather uniformly over the areas examined. It is probable that collections from still higher levels would show fewer and fewer animals in bark; limited observations support this view.

Owing to the differences in the character of the bark of the two species of pine trees, it was expected that each might shelter a characteristic fauna. The bark of the loblolly pine is thick and contains deep crevices at right angles to the surface, whereas the bark of the shortleaf pine is

made up to a greater degree of a series of lamina. The species and numbers of animals collected from the two were surprisingly alike however. Seventeen loblolly and seventeen shortleaf pines similar in

TABLE 1

A comparison of bark faunas of 17 loblolly and 17 shortleaf pines

Figures indicate total number of specimens collected

	LOBLOLLY				SHORTLEAF			
	3–15 in.	15–27 in.	27–39 in.	Total	3–15 in.	15–27 in.	27–39 in.	Total
GASTROPODA	1	0	0	1	0	0	0	0
CHILOPODA	13	6	3	22	15	6	3	24
INSECTA								
Collembola	5	4	0	9	2	2	2	6
Thysanura	8	3	5	16	7	3	4	14
Coleoptera	3	11	6	20	5	10	10	25
(larvae)	1	0	1	2	0	3	0	3
Orthoptera	9	6	9	24	3	2	3	8
(egg-cases)	12	7	3	22	9	5	9	23
Neuroptera	0	0	0	0	0	1	0	1
(pupae)	2	1	0	3	1	0	0	1
Diptera	0	2	1	3	0	1	1	2
(pupae)	1	0	0	1	0	0	0	0
Hymenoptera[1]	204	76	127	407	49	10	153	212
(pupae[2])	2	5	1	8	10	3	2	15
Lepidoptera								
(larvae)	2	3	2	7	2	3	2	7
(pupae)	0	1	2	3	1	2	0	3
Heteroptera								
(nymph)	0	0	0	0	0	1	0	1
ARACHNIDA								
Acarida	1	0	0	1	3	3	4	10
Phalangida	5	4	2	11	3	1	1	5
Araneida	25	27	33	85	26	40	26	92
(cocoons)	6	4	4	14	9	2	4	15
TOTAL	300	160	199	659	145	98	224	467
TOTAL exclusive of ants	97	87	74	258	96	90	74	260

[1] Hymenoptera parasitic on cockroach eggs excluded.

[2] Larvae and pupae of ants excluded.

size and location are compared in Table 1. In a few species there was significant variation. Cockroaches, ants, and phalangids were much more abundant in loblolly pines. There were a few more spiders on shortleaf than on loblolly pines.

There was apparently no marked seasonal variation when average numbers of animals per tree per month were compared. Fluctuations in numbers appeared to be correlated somewhat with certain environmental factors however. There was a general increase in the number of animals in bark with a rise in temperature. This was noticeable in the course of a single morning; each successive collection yielded a higher count than the last. The largest collections were made around noon; the numbers decreased somewhat through the afternoon. Humidity showed only slight correlation with the number of animals collected, though in general high humidity was accompanied by a decrease in numbers.

Grateful acknowledgement is made to the following for identification of specimens in the groups indicated: Dr. A. M. Chickering, spiders; Dr. C. S. Brimley, insects; Dr. C. F. W. Muesebeck, Dr. C. T. Greene, Dr. A. B. Gurney, Dr. R. A. Cushman, and Dr. Carl Heinrich, insect larvae and pupae; Dr. H. B. Mills, Collembola; Miss Caroline Powell, ants; Dr. Henry van der Schalie, Mollusca; Dr. G. W. Wharton, mites; Dr. Mary E. Walker, phalangids; Dr. Nelle B. Causey and Dr. R. V. Chamberlin, centipedes. I am greatly indebted to Dr. A. S. Pearse under whose direction this work was carried out, and to Miss Gladys Mitchell, who furnished some of the data incorporated in this paper.

SUMMARY

1. In the Duke Forest 147 square feet of bark of loblolly and shortleaf pine trees was examined at all seasons, and 1479 animals were collected from it, an average of 10.1 per square foot. These included the following species: insects, 78; spiders, 48; centipedes, 6; snail, 1; phalangid, 1; and of mites, 3; a total of 137 identified species.

2. Little difference between the faunas of loblolly and shortleaf pines was found. Cockroaches, ants, and phalangids were more abundant on loblolly pines; spiders were somewhat more abundant on shortleaf pines.

3. The greatest number of animals was found in the lowest square foot examined, near the bases of tree trunks, and there were progressively fewer in the second and third square feet. There were specific variations in this respect however.

4. The abundance of animals in the bark was directly correlated with temperature, and was shown to vary with the time of day. It tended to vary inversely with the humidity.

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IDENTIFIED SPECIES OF ANIMALS COLLECTED FROM PINE BARK AT DURHAM, NORTH CAROLINA

	Number Collected
CHILOPODA	
Cryptops hyalinus Say	1
Geophylus rubens Say	75
Lithobius forficatus Leach	1
Lithobius sp.	3
Nampabium virginiensis Chamberlin	1
Scolopendra woodi Mein	9
GASTROPODA	
Zonitoides arboreus Say	1
INSECTA	
Collembola	
Entomobrya nivalis Linn.	14
Tomocerus flavescens Tull.	5
Thysanura	
Machilis variabilis Say	37
Orthoptera	
Gryllus sp. (nymph)	1
Melanoplus sp. (eggs)	2
Parcoblatta uhleriana Saussure	15
Parcoblatta (egg cases)	58
Coleoptera	
Alobates pennsylvanicus De G.	2
Aulonothroscus sp.	3
Baeocera speculifer Csy.	4
Catogenus rufus Fab.	1
Chrysobothris floricola Gory	1
Elater verticinus Beauv.	1
Eros sp.	1
Helaps sp.	1
Lathridiidae	3
Lebia ornata Say	5
Lucidota atra Fab.	1
Melandryidae	1
Melanotus communis Gyll.	1
Melanotus fissilis Say	3
Melanotus sp. (larva)	1
Melyridae (larva)	1
Orthopleura sp. (larvae)	2
Paria canella quadrinotata Say	1
Platinus sp.	1
Platydema flavipes Fab.	1
Platydema sp.	1
Pterostichus adoxus Say	5
Ptilodactyla angustata Horn	1
Serica vespertina Gyll.	1
Spermophagos hoffmanseggi Gyll.	1
Tarpela micans Fab.	1
Tenebroides laticollis Horn	1
Tenebroides sp.	2
Tenebroides sp. (larva)	1
Zuphium sp.	1
Corrodentia	
Cinerea sp.	1
Psocus sp.	2
Timera sp.	1
Heteroptera	
Sinea sp.	1
Neuroptera	
Chrysopa rufilabris Burm.	1
Chrysopa sp. (cocoons)	2
Chrysopid cocoons	3
Diptera	
Psilocephala sp. (larva)	1
Sciara sp.	2
Hymenoptera	
Aphaenogaster tezana carolinensis Tryon	1
Amblyteles sp.	1
Apanteles sp. (cocoon)	1
Bezzia setulosa Loew	4
Braconidae (cocoons)	2
Camponotus caryae Fitch	187
Camponotus castaneus americanus Mayr	182
Camponotus herculeanus pennsylvanicus De G.	14
Camponotus herculeanus pennsylvanicus ferrugineus Fab.	3
Chalcidae	2
Crematogaster ashmeidi Mayr	63
Crematogaster lineolata Say	17

INSECTA

Hymenoptera

	Number Collected
Leptothorax curvispinosus Mayr	194
Myrmecina gramnicola americana Em.	1
Neodiprion sp. (cocoons)	13
Paniscus sp. (cocoons)	3
Pogonomyrmex badius Latr.	2
Prenolepis imparis testacea Em.	4
Solenopsis molesta Say	165
Solenopsis pergandei Forel	3
Syntomosphyrum sp. (parasitic on Parcoblatta egg cases)	33
Tetrastichus sp. (parasitic on Parcoblatta egg cases)	7
Vespula maculifrons Buy	1
Isoptera	
Reculitermes flavipes Koll	50
Hemiptera	
Metapterus annulipes Stal. (nymph)	1
Homoptera	
Fulgoridae (nymph)	1
Lepidoptera	
Blastobasidae (larvae)	7
Geometridae (larva)	1
Geometridae (pupae)	2
Malacosoma americana Fab. (larva)	1
Oletheutidae (*Eucosma*?) (larvae)	4
Phycitidae (larva)	1
Psychidae (larva)	1
Solenobia walshella Clem. (cocoons)	5

ARACHNIDA

Acarida

Allotrombium pulvinus Ew.	11
Erythraeus sp.	1
Phalangida	
Leiobunum sp.	16
Araneida	
Agelena naevia Walck.	3
Agelena sp.	12
Aranea corticaria Em.	1
Aranea sp.	2
Ariadne bicolor (Hentz)	9
Anyphaena sp.	1
Bathyphantes sp.	6
Ceraticelus fissiceps (Cambridge)	1
Ceraticelus sp.	1
Ceratinopsis interpres (Cambridge)	2
Cicurina sp.	1
Clubiona pallens Hentz	32
Clubiona riparia Koch	1
Coriarachne versicolor Keys.	11
Dictyna sp.	2
Dipoena nigra (Em.)	3
Drassus neglectus Keys.	1
Drassylus sp.	3
Epeira sp.	2
Erigonidae	3
Ero furcata Villiers	1
Herpyllus sp.	3
Lepthyphantes nebulosa Sund.	1
Leucauge venusta (Walck.)	1
Linyphia lineata (Linn.)	3
Linyphia insignis Blackwell	1
Lithyphantes sp.	1
Lycosa scutulata Hentz	1
Lyssomanes viridis Hentz	1
Marpissa undata (De G.)	16
Micrathena gracilis (Walck.)	1
Mimetus interfector Hentz	3
Mimetus syllepsicus Hentz	1
Oxyopes salticus Hentz	1
Oxyptila sp.	1
Pardosa sp.	1
Phidippus audax Hentz	2
Philodromus sp.	8
Robertus riparius (Keys.)	1
Salticus scenicus (Clerck)	4
Scytodes thoracica Latr.	1
Steatoda borealis Hentz	1
Theridion porteri Banks	2
Theridion tepidariorum Koch	2
Theridion sp.	30
Ulesanis americana Em.	1
Xysticus ferox Hentz	2
Zelotes sp.	1

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LETTERS FROM THE COLLECTION OF DR. CHARLES WILKINS SHORT

Edited by W. C. Coker

Through the generosity of the family of Dr. C. W. Short, The University of North Carolina has acquired all of the letters left in his collection after his death. We have gone over these letters and selected those we think will prove of some interest not only to botanists but to others of our readers. Most of them are to Dr. Short himself from prominent American botanists of the period. The greater number are from Dr. Asa Gray, and these, we feel sure, will be a welcome supplement to the series of his letters in two volumes edited by his wife (Riverside Press, 1894). Our thanks are due to Dr. J. G. deR. Hamilton and Mrs. Lyman Cotten, of the Southern Historical Collection in the University of North Carolina, for their courteous assistance in making these letters available.

We have with few exceptions arranged all the letters in chronological order, as the contents are not rarely consecutive in subject matter although from different correspondents. The letters are printed just as written except for omission of parts of two or three letters as indicated and for correction of a few obvious misspellings, punctuation, and some obscure abbreviations. Brief footnotes are added for information when individuals not widely known are mentioned in the letters.

In addition to these letters, The University has also been given Dr. Short's herbarium work table, which has been placed in our herbarium here, as an interesting museum piece.

Dr. Short was born in Woodford County, Kentucky, Oct. 6, 1794. He studied medicine at the University of Pennsylvania and was given the M. D. degree there in 1815. He became Professor of Materia Medica and Medical Botany in Transylvania University, Lexington, Ky., in 1825, and went to the University of Louisville as professor of the same subject in 1838. He retired to his home, "Hayfield," near Louisville in 1849 and died there on March 7, 1863.

During his entire mature life Dr. Short was intensely interested in

botany and corresponded with most of the prominent American and many European botanists of his time. Among his contemporaries Short was highly regarded as a careful, exact worker, and most painstaking in the selection and preparation of his plant specimens. The herbarium he acquired was a large one, and as Dr. Gray has said "is a model of taste and neatness." For an appreciation of this herbarium, given to the Philadelphia Academy of Natural Sciences after his death, see letter of Elias Durand to William Short, dated Feb. 24, 1864. Many of Dr. Short's duplicate specimens are to be found in the National Herbarium, Gray Herbarium, New York Botanical Garden, Missouri Botanical Garden, Kew, and over 400 at the British Museum of Natural History.

Dr. Short was a man of considerable means and was regarded, as these letters will show, as a prominent patron of the science of botany. The rare and beautiful flowering perennial *Shortia* of our Carolina mountains, famous for its history, found by Michaux and lost to botany for about seventy-five years, was named by Asa Gray for Dr. Short (see Garden and Forest **1:** 506, 1888; Amer. Bot. **32:** 66, 1926, etc.). This plant is frequently referred to in these letters (see especially the last one in this collection). There were also a number of species named for Dr. Short, several of which are listed in the letter just mentioned.

Dr. Short wrote no extensive works on botany but did contribute important papers on botany and biography. Most of these occur in the Transylvania Journal of Medicine. His "Catalogue of the Native Phanogamous Plants and Ferns of Kentucky" (with Robert Peter and Henry A. Griswold) appears in that Journal in 1833; his "Introductory Address to a course of Lectures on Materia Medica" in the same volume; and his "Biographical Memoir of H. Hulbert Eaton, A. M.," in the volume for 1832. For other items, see the list in the Catalogue of the Library of the Arnold Arboretum of Harvard University, Volume 1. For further biographical notes on Dr. Short, see the following:

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[*C. W. Short to William Short*]

Lexington, September 11th, 1838.

My dear Uncle,

Shortly after I had last the pleasure of addressing you, I went to Louisville, and spent there several days in the business of house-hunting. Having at length completed that matter for the present, by renting one for a year, I returned to Lexington a few days past; and, as I was on the point of writing to you again, I am favoured this morning with your letter of the 4th inst. and as I know not that I shall have soon a more convenient season to acknowledge it than the present moment, I lose no time in doing so.

I am gratified that the temporary arrangement I have made in Louisville concurs with your views; and I esteem myself fortunate that I have at length been able to secure in this way so comfortable a residence as I have. It is one among the best houses in the place, and one which I had before endeavored to rent, but the proprietor, wishing to sell it, had refused to rent; and only did so at last, in consequence of being unable to get his price. So that for one year, I hope, we shall be comfortably settled; and in that time, I trust, an opportunity may offer for a more permanent location on advantageous terms. There is certainly now no scarcity of houses for sale in that place; but the prices of all seem to me high, and but few of them meet my views in regard to locality, size, convenience, etc. It is certainly a matter of importance in so large a place, and where, of course, there are so many medical men, that the residence of a physician should be permanent and fixed; for a removal from one quarter, to a distant point of the same town, is almost as bad as an entire change of residence. This inconvenience I shall, therefore, endeavour to obviate as soon as I can. In regard to a sale of my Lexington property, I fully appreciate your advice, which I am glad to find concurs also with that of all my friends here, as well as my own opinion. . . . . As soon as this matter is disposed of, I shall be prepared to take up the line of march to our new home, where I trust we shall be established by the 1st of October, or very soon thereafter.

The Building, in progress for the Medical Institute of Louisville,

comes on admirably, and no doubt is entertained of its completion in time for the coming session. It is an admirable structure—equal to anything of the kind in the Union, and very far superior to any in the West. The purchases made in Europe during the summer of books, apparatus, etc. etc. are arriving: confident anticipations of success inspire the bosoms of all my colleagues; the citizens of Louisville continue to manifest the deepest interest in the issue: we have received from individuals in various portions of the western country, assurance of hearty cooperation; so that I trust we shall be, in a few months, "on the fully tide of successful operation."

You are pleased, my dear Uncle, to inquire the title of the British publications to which I referred, as containing a mention of myself. They are *Curtiss' Botanical Magazine;* in the last six or eight volumes of which frequent reference is made to me, especially under the heads of "Hydrastis Canadensis," "Silene Virginica," "Bellis integrifolia," etc. etc. The *Flora Boreali-Americana,* by Sir W. J. Hooker, 2nd vol. under the head of "Aster Shortii," and elsewhere. The *Journal of Botany,* by the same author, under the head of "Drummond's* collections in N. America," "Cyamus luteus" etc.—*Icones Plantarum,* by the same, article "Draba dentata."—*Companion to the Botanical Magazine,* under the mention of "Podostemum ceratophyllum," and other places of the same work.—These are a few references to these foreign works, which I now recollect—I could mention many others, but that my library being packed up, I am unable to have access to it. All the recent publications on this Science in our own country give me ample credit for my contributions; as *Gray's Elements of Botany—Torrey & Gray's Flora of N. America—Darlington's Flora of Chester County (Pa.)—Eaton's Manual of Botany,* 7th Edition: besides various papers by different writers in *Silliman's Journal, Journal of the Academy of Natural Science of Philadelphia, Annals of The Lyceum of Natural History of New York,* etc. etc.—With this dry detail of references I must close this letter, only adding an expression of the sincere attachment and affection with which I am, my dear Uncle, yours very truly

C. W. Short

* Thomas Drummond (1780–1835), a Scotch nurseryman and later curator of the Belfast Botanic Garden, who came to America in 1825 as assistant naturalist to the second Overland Arctic Expedition. He travelled in northern and northwestern United States and later in western Texas. In 1835 he came to Apalachicola, intending to explore all the Florida peninsula, but on a trip to Havana, Cuba, suddenly died there in that same year. The familiar Drummond phlox of gardens was found by him in Texas.

[*Thomas Nuttall to C. W. Short*]

Rainhill near Prescot, Lancashire.
Jany, 24th 1849

Professor Short,
Dear Friend,

I have not now had the pleasure of hearing from you for a very considerable time but I hope you are in the enjoyment of your usual good health and spirits.

I have not been lately doing much in Nat. History, more than amusing myself in the cultivation of plants in which I yet take my usual interest. Minerals have somewhat occupied my attention of late; tho' last winter I paid a visit to Philadelphia and New York and sailed from Boston by the steamer. While in Philadelphia I undertook to describe and publish a century of plants selected from a set collected for me in the Rocky Mts. and Upper California: these have appeared in the Journal of the Academy of Nat'l Sciences, and I have received some copies in England.

If this spring you could collect for me a few seeds of my old favorite *Collinsia verna*, which has never yet been seen in England, the *Synandra**[,] *Dracocephalum cordatum*, I should be exceedingly pleased to see them growing in my garden as a reminiscence of past times so pleasing when yet young and healthy I saw them first growing in my favorite *land of the West!*

Erigenia will be in flower when this scrawl reaches you. Of this I think you once sent seeds but they did not grow, the bulbs probably would. These things sent to our friend George W. Carpenter, Druggist, Market Street, Philadelphia, will be directly transmitted by him to me as soon as they arrive. May I beg of you in your great kindness to excuse this begging and tasking you, when you bear in mind that if I am ever to see those things it must either be by you or not at all.

In return is there any thing I can do for you on this side the Atlantic, if so let me know and I will attend to it at once.

Your obliged friend and servant
Thos. Nuttall

* Nuttall's genus *Synandra* still holds, but his species has been superseded by the earlier name, *hispidula*, of Michaux. His plant is now known as *Synandra hispidula* (Michx.) Britton. *Dracocephalum cordatum* is now known in this country as *Meehania cordata* (Nutt.) Brit.

[*Thomas Nuttall to C. W. Short*]

Sutton near Prescott, March 13th, 1850

Dear Friend,

It is now a long time since I had the pleasure of hearing from you but hope you are in the enjoyment of good health as I am at the present.

I have since my visit to the U. S. in 1847 done nothing in botany or in any other department of Nat. History except the effort of adding to my cabinet of minerals. I still take great delight in the cultivation of my garden, and always rejoice to see with the return of the seasons some "old favorite faces" in the plants of America which grow in my garden, and which are always amongst the favorites of my collection.

Strange to say, I have never yet been able in any way to obtain the seeds of my great spring favorite *Collinsia verna*, which tho' the first known and the most common has never yet reached England.

Will this note reach you in sufficient time to collect and send me a few seeds by letter to our friend G. W. Carpenter, Druggist, Market Street, who will transfer the same to me.

You once sent me seeds of *Erigenia* but they would not vegetate. *Sinandra* [*Synandra*] too has never been seen yet in England.

I am presuming to impose on you a tax, but I think nothing whatever of the plant kind would please me more than *one sight* more at my early favorites. You will therefore I make no doubt excuse the strong desire I feel before I die to see those plants again.

[Signature cut out but certainly from Thomas Nuttall]

[*Thos. Nuttall to C. W. Short*]

Rainhill near Prescot
Lancashire, Jany. 26, 1854.

Dear Friend

You can scarcely conceive how much I was delighted to receive from you the packet of seeds of *Collinsia verna*. I planted them as you directed but not one germinated—their vitality was gone in some way I cannot account for but may I beg of you still to take the trouble of once more collecting some for me in the coming season when perhaps I may be more successful. Send a few in a small packet by post and I shall probably receive them in safety.

We have had a visit from Mr. Lea* of Philadelphia whom you know as a conchologist.

Our winter here has been as cold as any in Pennsylvania tho' now nearly over for the present. I enjoy good health as yet and hope you do the same tho' we are both far descended into the vale of years.

[Signature cut out but undoubtedly from Thomas Nuttall]

* Isaac Lea (1792–1886), born in Wilmington, Del. When he was fifteen years old he moved to Philadelphia, where he was later for many years engaged in publishing and bookselling. He wrote on mineralogy, fossils, geology, etc., and was an authority on fresh-water mussels.

[*Asa Gray to C. W. Short*]

Cambridge, March 28th, '49.

My dear Doctor,

The first package of Gregg's* plants, which you forwarded to me so long ago, by some mischance fell into the hands of a Professor *Alonzo* Gray, Brooklyn, N. Y., who seems to have detained them a long time, so that they only reached me when my Plantae Fendlerianae† was nearly through the press; as you will see by a note near the last part, in a copy which I forwarded to you some time since, and which I hope you duly received.

Your second package came in good season to Dr. Torrey, who kindly divided it with me. There were many good and interesting things in these collections, as well as in those of Wislizenus‡ from the same regions. And I have lately sent a collector, Mr. Charles Wright, § to go across from Texas into those regions, south of Santa Fé, to see if more cannot be gathered from those new interesting countries.

The rest of Plant. Fendl. will be coming out, I hope, before a great while; but I am at present busy on the 2nd volume of Genera, which will be published before long, and which I hope you may be pleased with.

I am exceedingly driven with work, or I should have written long before this; but letters unanswered are apt to accumulate in enormous piles, while I am engrossed with more pressing things. But, believe me, I shall always be glad to hear from you.

With best regards,

I remain yours truly,

Asa Gray

* Josiah Gregg (1806–1850), Santa Fé trader and author, born in Overton County, Tenn. He published *Commerce of the Prairies* in 1844. He travelled

extensively through the southwest, including parts of Mexico and was a keen scientific observer. A number of plant species have been named for Gregg.

† August Fendler (1813–1883) was born in Prussia and came to Baltimore, Md., in 1836. He worked at various occupations, and wandered over many parts of the central and western United States, Isthmus of Panama, Venezuela, collecting plants for various herbaria. He died on the Island of Trinidad.

‡ Friedrich Adolph Wislizenus (1810–1889), German physician who came to this country in 1835, settling first in New York. He later lived and travelled widely in the west and in Mexico, collecting many plants. These were described by Engelmann in his *Sketch of the Botany of Dr. A. Wislizenus's Expedition* (Washington, 1848), and included many new species as well as the new genus *Wislizenia*, named for the discoverer. He spent the latter part of his life in St. Louis.

§ Charles Wright (1811–1885), botanist and collector of plants, born in Wethersfield, Conn., where he also passed the later years of his life. In 1837 he went to Texas and spent two or three years botanizing there, while supporting himself by surveying and teaching at various places. Later he extended his explorations farther south and west along the Mexican frontier and made a collection which forms the basis of *Plantae Wrightianae*, published in the Smithsonian Contributions to Knowledge. Wright went on a tour around the world with the North Pacific Exploring Expedition under Captain Ringgold, leaving Norfolk, Va., in 1853. In the fall of 1856 he began his long exploration of the botany of Cuba, which resulted in many rich collections. These were published by various botanists, mainly Prof. Grisebach of Göttingen, Amos Eaton, Berkeley and Curtis, Sullivant, and Tuckerman.

[*Wm. Darlington to C. W. Short**]

West-Chester, Penna., Sept. 12, 1849.

My dear Sir,

Much of my leisure time, for the last two years, having been occupied with compiling and transcribing the *correspondence*, alluded to in the annexed *Prospectus*,—and in revising the *Proof sheets*, for the Publishers,—I thought I would send you the *Prospectus*, to apprize you of what was going on: believing it to be a subject in which you would feel some interest. I do not, however, send the Prospectus with any interested motive, in the way of *subscriptions*—but merely for your information: for I have no interest whatever in the publication. I made *a present* of the ms. to the Publishers, on condition they would issue it in decent style;—which they have done. It is now all printed, and makes a handsome 8vo Volume of 585 pages. I presume the publishers will send a few copies to the West. If you should get hold of it, I should be gratified to hear how you like it. I have such a passion for *antiquities* of that

description, that I may be deceived in my estimate of these; but I think you would be amused, and interested, in the perusal.

Very sincerely, Dear Sir, your old friend,

Wm. Darlington

Prof. C. W. Short,
Louisville, Kentucky.

* This letter was written on the inside of a folder which presented: "Proposals for Publishing by Subscription, Memorials of John Bartram and Humphry Marshall, The Eminent Pennsylvania Horticulturists, Botanists and Naturalists, with Occasional Notes and Biographical Sketches, by William Darlington, M. D."

[*W. H. Harvey* to C. W. Short*]

Charleston, S. C.
March 12, 1850.

Dear Sir

When I saw you last winter in Philadelphia I fully expected to have had the pleasure of calling on you at Louisville, but I have not been able to make out time for the Great Valley—I must now defer visiting the western country until my next tour in America, whenever that may be. I have been spending the last month on the Florida Keys where I went for the purpose of exploring the marine vegetation, and I had originally intended going on from Key West to New Orleans up the River—but found that I could not do so without sacrificing the object which led me to Key West. So, with great reluctance, I have been compelled to retrace my steps homewards.

You mentioned, when I had the pleasure of seeing you, that you had a considerable mass of duplicates of Kentucky plants and kindly offered to put up a set for our Dublin Herbarium. Should you have had leisure to select them since your return home I shall be very glad to receive them. If there be an Express from Louisville to Washington, D. C., they might be addressed there: Prof. Harvey, care of Prof. Henry†, Smithsonian Institute, Washington, D. C., or if you could equally well send them to New York, my address there is:—Prof. Harvey, care of Messrs. Abm. Bell & Son, 117 Fulton Street, New York. Messrs. Bell & Co. correspond with Mr. Saml. Nicholson, Merchant, New Orleans, who would doubtless take charge of any parcel addressed to their care, if sent to him—but I have personally no acquaintance with Mr. Nicholson. It would therefore be well, should you send via New Orleans, to ask Mr. N. to forward at once to Messrs. Bell.

I purpose returning to Europe by the first steamer in May—but if the parcel did not arrive in time to go with me, Mr. Bell would take care to forward it.

I shall be very glad to hear from you, and to reciprocate your botanical favours in any way in my power that may be most agreeable to you. I have still remaining undistributed a few Californian plants collected by my predecessor Dr. Coulter,‡ which I shall be glad to send you—and if you care for South African plants I could also send you a collection. I have also generally by me a considerable number of duplicate marine Algae, should you feel an interest in such things.

Believe me, Dear Sir
very truly yours
W. H. Harvey
of Trinity College
Dublin

I leave Charleston for Washington, D. C., in a few days, and remain with Prof. Henry for about a fortnight.

* William Henry Harvey (1811–1866), botanist, born near Limerick, Ireland. He was professor of botany in Trinity College, Dublin. He travelled in eastern America in 1849–50, and published his *Nereis Boreali-Americana, or Contributions to a History of the Marine Algae of North America*, 1852–1858, in three parts in the Smithsonian Contributions to Knowledge.

† Joseph Henry (1797–1878), a physicist, born in Albany, N. Y. From 1832–1846 he was professor of Natural Philosophy at Princeton. In 1846 he became the first secretary and director of the Smithsonian Institution and remained there for the rest of his life. He independently discovered the induced current but did not publish his findings. Faraday published his own discovery in 1831.

‡ Thomas Coulter, predecessor of W. H. Harvey as keeper of the herbarium of Trinity College, Dublin. He died in 1843.

[*W. H. Harvey to C. W. Short*]

Washington—March 27—1850.

My dear Sir:

I have received your very kind letter of the 19th informing me that you had sent me a parcel of plants to the care of Mr. Carey, New York. Mr. Carey is an old friend and correspondent of mine, and will take excellent care of the parcel till I claim it from him.

I shall not fail, on my return to Europe, to prepare a parcel for you

and shall put in it as many of Coulter's plants as still remain undistributed.

Believe me, Dear Sir
Very sincerely yours,
W. H. Harvey

[*Asa Gray to C. W. Short*]

Cambridge, March 21st, 1850.

My dear Sir,

I had the pleasure to receive today your letter of March 13th. and will immediately reply to its points.

Harvey will be in New York in time to return to Europe early in May, and Carey* will give him your parcel as I may not see him. I will instruct him about Reichenbach which must also go from New York and Dr. Hietz' with it.

I shall be happy if I can serve you in any way.

The printing of Plantae Lindheimerianae† has gone on very slowly; I will send the sheets as soon as done up to Compositae.

I immediately wrote to Putnam, New York, to send you two copies of Genera Illustrata through Morton and Griswold; perhaps he has scarcely had the opportunity yet.

Wright's plants will not be very numerous I find, not more than 4 or 500 species after the very first sets, and not more than 12 sets in all. But they are extremely good plants and with considerable novelty. I can have a set for you as soon as distributed, notify you of the number and amount, and you can remit to Sullivant the money; for I shall ask him to look after Wright's pecuniary affairs a little while I am away.

I will look after Shortia in Paris. I am mortified that it has not been found yet.

The plant you raised from seeds is Hymenoxys californica, Torr. (Ptilomeris, Nutt.).

I wish I could get through the Flora!

We hope to be off early in June. I am how hard pressed with 3rd Edition of Bot. Text Book, the first part of which I have rewritten and enlarged making it a small 8vo. It has cost much time and labor, and put back other things sadly.

I remain with much regard,
Yours faithfully,
Asa Gray

* John Carey, an Englishman who spent the years 1830–1852 in the United

States and devoted most of this time to botanical work, especially assisting Asa Gray in the preparation of his publications.

† Ferdinand Jacob Lindheimer (1801–1879), a German who lived in Texas and collected plants there for over thirty years. *Plantae Lindheimerianae*, published by Engelmann and Gray in Journ. Boston Soc. Nat. Hist. **5**: 210–264, 1845; **6**: 141–240, 1850, was based on his findings and contains many new species. The genus *Lindheimera* was named for him.

[*Geo. Gilliss to C. W. Short—April 12, 1850.*]

With my compliments please receive a few strawberry seeds sent me from "Santiago, de Chiele"—by my son Lt. Jas. M. Gilliss of the U. States Navy—in a letter dated 30 Dec. 1849. He says "We have now in season, oranges, cherries, strawberries, plums, pears, figes, watermellons, green corn, etc.—: strawberries most extrordinary in size, many being as large as the Guinea fowls' eggs. I send you some seed."

Yours truly
Geo. Gilliss
Louisville, Ky.,
Apl. 12, 1850.

Note—The above strawberry seed were properly committed to the ground in the spring of 1850, but there after care being confided to a stupid Dutch cabbage gardener, they were *of course*, neglected and lost.

C. W. S.—
Aug.—1850

[*John Torrey to C. W. Short*]

Princeton, N. J.,
Aug. 24, 1850.

My dear Sir,

I was greatly pained to learn the sad cause of your sudden return to Kentucky. You have again been stricken sorely and I pray you may be sustained by Him who acts wisely and benevolently even in the afflictions which He brings upon us.

Much did I expect to enjoy in our purposed excursion. It was not till a week after the time I was to meet you in Philadelphia that I heard of your return home. I informed Dr. Darlington of our intention, and he expresses much sympathy for your loss. If I can get away next month I shall make him a visit by myself.

The scientific meeting at New Haven is well attended; and I suppose you read the proceedings in the newspapers. I spent three days there

this week, but was obliged to leave, as my duties in the college required my presence here. There is some prospect of the next meeting being held in Cincinnati, and if the Association should conclude to go there, I shall hope to see you *in situ* (D.V.*) next year.

Are you a subscriber to Mr. Wright's Texan and New Mexico expedition? Several gentlemen made up a purse for him, but the poor fellow is getting quite low in funds, and I, for one am unable to do any more for him. Dr. Gray is in Europe and could hardly keep up regular correspondence with him. It was from Dr. Gray that Mr. W. received all his remittances. I thought from a remark which you made when I had the pleasure of seeing you in Princeton, that you might be willing to lend some aid to Wright, and receive a share of his collections. He is probably at this time exploring the northern part of Texas, but any thing for him can be directed thus:

Mr. Charles Wright
San Marcos, Hays Co.
Texas.

Mr. Wright's previous collections are in Dr. Gray's hands, save what may be distributed among the subscribers. You will soon be able to judge of their value, by a list of them which Dr. Gray will publish. He is to send his notes from England.

With high. regard,
I remain yours,
John Torrey.

Prof. Short.

* *Deo volente.*

[*S. B. Buckley** *to C. W. Short*]

Starkey, Yates Co., N. Y., Sep. 2. 1850.

Dear Sir

Dr. Torrey told me a few days since that you have become possessed of a large fortune, part of which you were anxious to expend in advancing the Science of Botany. The region around Salt Lake is almost entirely unexplored. I should like to start next spring and remain a year with the Mormons and then proceed to California and explore that and then return home and publish whatever I obtain new. If you will furnish the means I will perform the labor of collecting—furnish you with a suite of the botanical specimens collected and we will jointly publish whatever is new. If this proposal does not suit you I shall probably undertake the business at any rate next spring. I think there is a great chance for discovery, no botanist having visited the region excepting

Fremont and he only passed through and afterwards lost part of his collection. Let me hear from you soon and direct to this place.

Yours truly
S. B. Buckley

* Samuel Botsford Buckley (1809–1884), native of New York state, a naturalist of broad interests who travelled extensively in the south collecting plants, fossils, shells, insects, etc. The remarkable and rare shrub *Buckleya* of the southern Alleghanies was named for him. The latter part of his life was spent in Texas, where he was at two different periods state geologist. Among his discoveries was that of a skeleton of *Zeuglodon* 70 feet long in Clarke County, Alabama, in 1841. See the next letter.

[*John Torrey to C. W. Short*]

Princeton, Sept. 21st, 1850.

My dear Sir—

Your letter of Sept 11th, inclosing a check for one hundred dollars, reached me two days ago, but I have been so closely occupied in delivering some extra lectures (in the absence of a brother professor) that I could not well acknowledge your favor before. You have been extremely liberal to Mr. Wright, and in thus aiding him have done much for North American Botany. Although I do not think you have contributed so handsome a sum to get an equivalent in dried plants, I have no doubt Mr. Wright will send you sets of his choicest specimens. I shall take means to get your contribution in his hands.

I am well acquainted with Mr. S. B. Buckley. He has corresponded with me on botanical matters for eight or ten years. He has explored in Illinois and other western states. For several years he resided in Alabama, where he collected largely. He has also explored the mountains of Tennessee, the Carolinas, Georgia, and Virginia. Afterwards he collected in Florida. I believe him to be an honest man, as he is certainly a zealous collector. He needs a little training as to the quality of his specimens—but I think he would engage, if sent on another expedition, to collect specimens that would be unobjectionable. For several years past he has not attended much to Botany—but his zeal for the science seems unabated. When I saw him lately at the Scientific Meeting in New Haven, he expressed a strong desire to visit the Rocky Mountains in some far western region, and I mentioned to him that the neighborhood of the Salt Lake would offer a good harvest of interestl ing plants. I happened to be talking about you—and of your libera- offer to contribute towards botanical surveys, but don't think that I encouraged him to hope any thing from you. When he went on the

Florida expedition, his means were quite limited, and he was badly provided for making collections. Hence his specimens were poor. In making up his sets, too, he made them rather scanty, but on all other occasions he has been (at least to me) quite liberal. I really think he would do very well to explore the far west. He is quite trustworthy, has had much experience in collecting, and is pretty well acquainted with North American Botany. If I could afford it, I would without hesitation aid in his outfit—but I can, at present, do very little in this way.

As to those fossil bones—Buckley collected them with great labor, and considerable expense. He was desirous of disposing of them to some public institution for a fair sum—and even offered them to a society in England—but was finally obliged to dispose of them for a hundred dollars or so to Dr. Emmons of Albany. When I last saw them they were in the New York State Geological Rooms.

I am sorry on many accounts that Dr. Gross has concluded to leave the Medical Institution of your city—although I believe he will be a valuable accession to the profession in New York. We have reason to believe that he will not find the income of his new chair equal to what it has been represented to be. I doubt not he is a better teacher than Dr. Mott—Although, his name is not yet so great. It is natural enough that I should not be glad to have a man of Dr. Gross' talent in the opposition school—but you may be sure he will be well received by all my colleagues, by whom he is well known and greatly respected. I shall be glad to make his acquaintance,—for there is no reason why we should not be on excellent terms. Dr. Dixon, who lately resigned in Dr. Mott's school, was much respected by our professors, and visited them at their houses. We shall cordially welcome Dr. Gross to our city—sorry as we are to have him a rival.

As soon as I hear from Wright again, I will inform you. Please let me know what are your favorite tribes of plants, and I will ask him to collect these especially for you.

I am my dear Sir,
with high esteem—
yours
John Torrey

[*George Engelmann to C. W. Short*]

St. Louis, Nov. 28, 1850.

My dear Sir:

Your letter of Sept 23 was received in due time, and would have been

answered sooner, if I had had any thing to communicate interesting to you. Your specimens sent to me so long ago have not yet, I am sorry to say, received the proper attention.

What you tell me about your acquaintance with our lamented friend Dr. Gregg is quite interesting and characteristic. If we could learn any thing more about him, to complete a short outline, you as the historian of western Botany and as Gregg's first instructor in Botany should publish a sort of necrolog in Silliman's Journal or some other work. I have written to a brother of our friend in Louisiana about some data, and also to learn, whether any thing had been left by Dr. Gregg in California, though I doubt that, as he had been there only in fall and winter.

Dr. Mead* sent me a package of plants for you a short time ago which I gave to Dr. Shumard of your city, who I doubt not has placed it in your hands by the time this reaches you. I wish we had a trustworthy Botanist to collect about the Salt Lake; I would pay a small share with pleasure; but Buckley makes very poor specimens.—Wright's are not very good, either, can not compare with Fendlers' or even Lindheimer's. —Where is he now?

What you tell me about your sojourn east was very interesting to me. If I could get away from my practice I would enjoy a few weeks east very much. But my medical practice chains me to the spot. You know that we again had Cholera here; though only about one tenth of what it was last year.—It showed itself again within this month! All that has kept me more busy than ever, and left me no time at all for botanical studies!—I am just now preparing Dr. Gregg's Magellan Collection for Prof. Gray, to be sent to England to him, to be studied.

If I can learn any thing more about Dr. Gregg I shall inform you of it.

Very truly
My dear Sir
Yours etc
G. Engelmann

P. S. I see in the papers that you are going to send a naturalist out to Liberia—is that so?

*S. B. Mead (1799–1880), a physician and botanist, born in Connecticut, who lived from 1834 until his death in Augusta, Illinois. He collected and studied the plants of his region and exchanged widely with the botanists of his day. He discovered the rare *Asclepias Meadii*, named for him by Torrey.

[*M. A. Curtis to C. W. Short*]

Society Hill, S. Car.
March 24th, 1851.

My dear Sir.

I was much gratified a few days ago to see your hand again, which was formerly so familiar to me. I must here declare, that it is no fault of mine that it has been so unfamiliar for the last few years. I have written once certainly, I think twice, since your last letter to me in Feb. 1846. I had however looked upon this cessation of correspondence as natural enough. We had little or no new matter to communicate, and in the love and eager search of something new we had gradually sought and obtained new sources of novelties, until we had insensibly lost each other. Still, I had not *forgotten* you and never shall. Though I have nothing new to offer you, it will give me pleasure to hear from you when you can conveniently devote a half hour to auld lang syne.

I have, as you intimate, exhausted the field around me, so far as Phanerogams are concerned. But long habit demanded the continuance of botanical research, and so I must needs look to Cryptogams for novelty. I have tried each Order of these, except Algae, and have at last settled down upon Fungi upon which I have been engaged for five years. These now enlist my interest as strongly as ever did the Phanerogams, and they have the advantage of supplying a large amount of new species. The field is large enough too, within the very narrow limits that I can occupy, to give me as much employment as I desire for the rest of my life.

As to the more important subject of your letter I cannot speak very positively. Ten or dozen years ago the house at the Warm Springs had a good reputation and was much resorted to. How things are conducted now I cannot say. Upon the quality of the Springs I can merely say, that they are *warm*, a quality that I never had occasion to covet during my rambles in that region. I once dipped my hands in to one of the Springs for mere curiosity.—But if you desire to pass a few weeks in one of the most interesting and attractive regions in the Alleghanies, I should recommend a sojourn upon the French Broad. A fine house is kept at Asheville, 30 miles above the Warm Springs, where you are within a day's ride of Black Mt., Pisgah, Balsam Mts., & Hickory Gap, the latter the most imposing gap in N. Carolina. I think the Shortia is to be looked for now upon Black Mt., and it would be a matter of no small interest if you should be fortunate enough to rediscover it.—Between Asheville & Warm Springs is abundance of Philadelphus hirsutus, Nutt. Below the Warm Springs you will find Buckleya (Borya

distichophylla, Nutt.) and in the mountains around, Andromeda floribunda, Pursh, all which are very rare. I have myself collected only the first, and not in flower. I have herborized but a single day along the French Broad.

I have it sometimes in mind that I shall have to take an excursion for health next Summer, and if you should conclude to go to the Warm Springs, and I go anywhere, I will join you there. In November last, in January last, and now again this month, I have had attacks of a sort of nervous Rheumatism, which wear sadly upon me. If I do not recruit at home, I must needs recruit abroad. I am now very feeble, creeping about house like a man of 80 yrs. But I hope to straighten up in a few days.

Let me know when you have concluded on your course. Dr. Hardy of Asheville, and also Mr. Clingman (*M.C. of some note*) of the same place are pretty familiar with the Mountains and can give you important directions, if you should wish to visit the mountains in that region.

Ap. 7th—After writing the above I was obliged to take to my bed again, where I have lain until yesterday. I hope the disease is routed for the present. As to a permanent cure, it is hardly to be looked for.

If you are inclined to turn your attention to Fungi, I shall be very glad to give you any assistance, in the determination of specimens, etc. The small sorts, growing upon dead leaves, sticks, bark, wood, etc. can be sent by tens & twenties in a letter. I receive them almost weekly in this way from correspondents. If you have good eyes, and can easily use a Microscope of 300 or 500 power, you will soon find beauty and variety enough among the Fungi to enlist a strong interest in them. With the fleshy species, or Mushroom, I would not advise you to meddle at first. These are difficult to discriminate, and troublesome to preserve.

I am feeble and do not feel like writing more. Let me hear from you again. Believe me

very truly your friend
M. A. Curtis.

[*M. A. Curtis to C. W. Short*]

Charlestown, Mass.
Sept. 9th, 1851.

My dear Sir,

I have just received your letter of Aug. 9th, which has followed me hither through the two Carolinas. I am obliged to you for the letter

from Reichenbach, to whom I will write some time. I doubt if I can do much for him.

I intimated to you in my letter of March last that I should probably have to leave home, if I did not make some progress soon towards former state of health. Three Rheumatic attacks in five months were rather more than I could stagger under without some unusual effort. I therefore left home the latter part of May for the Hot Springs of Virginia, a few weeks use of which worked charmingly. When I got there (June 17th) it was hard work to go up stairs, I was so feeble. On the 4th & 5th July I spent several hours in clambering over mountains. From that time I have gradually recovered vigor, and I am happy to say that I am now in good health.

If you had gone to the Warm Springs of N. C. and I had joined you there, as I thought I would when I wrote, you would for some weeks have had a poor companion in mountain excursions. I am sorry that your health is not very firm. I think you would find pleasure and health in a residence at the various springs of Virginia. The air is bracing, and the scenery attractive;—and if you are any way ailing, you will find some of the various waters probably suited to your case.—Some of these Springs are places of much resort in the Summer.

I hardly think there can be any mistake about the Shortia. It is an early flowering plant probably, and later Botanists have not been in the proper region by some weeks as early as old Michaux. Besides it might very easily be passed by for a Pyrola. I rather think, if I had a whole Summer to myself in those "hautes montagnes", that I could bring it to light. I would give no small sum to rediscover it.

Gray got home last week, and looks remarkably well. I was with him a short time this morning, and expect to spend tomorrow with him, though I shall have to be cautious how far I intrude upon one so industrious as he.

We have quite a number of eatable mushrooms, not only of Agaricus, but of Lactarius, Cantharellus, and Boletus. Some species of these genera are however desperately poisonous and no one should venture to eat any species unless he is quite familiar with it. There are no rules by which a poisonous species can be distinguished from the wholesome. If however you know the Ag. campestris, you know the highest flavored species we have, and need not desire another. I use myself chiefly the Ag. fabaceus,* *Berk:* first discovered by Lea in Ohio, and have a bed of it. It is very closely allied to the other, but besides a few other distinctive characters, it has when fresh broken a strong odor of peach

kernels, which belongs to no other known species. I should not be surprised if your "A. campestris?" was this.

The *Truffle* which Kalm alludes to, I have no doubt is the Pachyma Cocos,† *Fries*, found from Virga. ! to Texas, and sometimes larger than a man's head. It has no affinity to the Truffle. It originates on wood beneath the earth, mostly on roots of Trees, and is a solid mass of what Braconnot calls *Pectin*, but which Torrey long before had named *Sclerotin*. Of course then it is eatable as much as an Irish Potatoe, but is quite tasteless. It is known as Tuckahoe or Indian Bread.

An old German of Penna. told Schweinitz that in that State he had found the Truffle, hunting it with his dog as is done in Europe. This is all that is known of Truffles in this Country. No Botanist has seen one, and no one else can well be trusted. It would afford me great pleasure to get specimens from any part of N. America. I have 7 or 8 species from Europe. The name of the common Truffle is *Tuber cibarium*.

I expect to leave here on the 16th, spending a few days in N. York, two or three weeks in Phila., and to reach home about the last week in Oct.

I shall be glad always to hear from you, and will assure you of the continued esteem & respect,

of, my dear Sir,
yours truly
M. A. Curtis

* Not *A. fabaceus* Berk. but the plant that Curtis later called *A. amygdalinus*. As this name was never established by published description, the plant was later renamed *A. auricolor* by Krieger (Mycologia **19:** 308. 1927). See also Mitchell Journal **43,** p. 249, 1928.

† The real affinity of this peculiar growth, which is a parasite on the roots of various plants, was not known until 1922, when Dr. F. A. Wolf of Duke University proved it to be a *Poria* (Journ. E. M. Sci. Soc. **38,** p. 127, 1922). Tuckahoe has been known to reach the weight of 22 ¾ lbs. (see note in this Journal **43,** p. 135, 1927).

[*John Torrey to C. W. Short*]

Princeton, Augt. 7th, 1851.

My dear Sir

A few days ago I received your welcome letter of July 24th. The enclosure for Dr. Knieskern* was forwarded to him immediately.

I know not what has become of Buckley, but I rather think he has

gone to California. He has not written to me since last autumn. You may be sure he is not offended with *you*, but I fear he thinks that *I* might have obtained a situation for him in California.

At the last accounts Wright was doing well in Texas. He expected to be in El Paso under the protection of Colonel Graham† and from thence to make excursions into the surrounding country. In this way he will probably anticipate much that the Mexican Boundary Commission hoped to accomplish. The botanists under Mr. Bartlett were on the ground last autumn, and although they will probably get all that Wright will find and more too, *he* will be *out* before them. Dr. Gray published (or rather printed) the first sheet of Plantae Wrightianae before he left for Europe, and, I suppose, will resume the article on his return, which will be about the 7th of September.

I hoped long before this to have sent you a copy of a little paper of mine on some new plants collected by Frémont in California, but there have been various hindrances in the way of its completion. It is now ready for the printer, and will soon appear in the *Smithsonian Contributions*.

I am right glad that you are getting more interested in botanical pursuits. At one time I was afraid you were going to retire from the field.

I wish you would send a young botanist into the mountains of North Carolina to look for the Shortia. What would I not give to see complete specimens of that plant! In studying the affinities of Pyroleae and Monotropeae lately I had occasion to refer to the Shortia. Really it is tantalizing to have such an interesting plant in our neighborhood, as it were, and not be able to lay our hand upon it. If I had less to do at home, I would find it, if it has not become an extinct species.

I keep at work every day (more or less) on our favorite science, and my zeal does not flag in the least. In this place, however, I labor under many disadvantages, chiefly from want of books, that I might command in a large city. I have sold my house in Princeton, and shall (D. V.) remove to New York by the first of November.

[Not signed but surely from Dr. Torrey]

* Peter D. Knieskern (1798–1871), a physician who botanized over the New Jersey pine-barrens.

† J. D. Graham, chief astronomer of the Mexican Boundary Commission. He was later replaced by Major W. H. Emory.

[*Asa Gray to C. W. Short*]

Cambridge, Jany. 17th. 1852.

My dear Dr. Short,

Pray forgive my delay in answering your kind favor of the 16th Dec. When it reached me both Dr. Torrey and Mr. Carey were with me, and the latter left us only last week. I have been much pressed by the printer with *Plantae Wrightianae*. I shall have the sheets to send you ere long; that is of part 1, up to the end of Compositae (some 200 pages). There I stop till I can take up the Monopetalae of this, Lindheimer's, Fendler's, etc. collections all together for part 2.

In Wright's letters (I had one yesterday) he expressed much anxiety about securing a set of his plants for you, to repay your kind advance and is troubled about it, lest his connexion now with the Boundary Survey (where he has a *small* pay) and the delivery of his packages to Col. Graham, should prevent his having control of them. But Col. Graham has sent the 1st envoi to me, and is bringing the second: and you may rely upon my looking after your and Wright's interests. I trust that Graham will be content with a single set for Government, when besides yours, there will be several others to turn to Wright's benefit. The portion I have got abounds in *very interesting* plants.

May I not hope that you will soon make a second visit eastward, and allow Mrs. Gray and myself the great pleasure of welcoming you here!

I am glad you will prepare a notice of Gregg. In the 1st sheet of *Plantae Wrightianae* printed before I went abroad (I thought I had sent you a copy) you will find a curious new genus of Cruciferae, which I have dedicated to Gregg's memory. I have also figured it. You shall have it ere long. If you look through Pl. Fendlerianae, the 2nd Pl. Lindheimer[ian]ae, and the forthcoming Pl. Wrightianae, you will see continual notices of new things from Gregg's collections. That region was almost all new when he began. Torrey has spoken of the parcel he left at American Institute, New York, and fears it is by this time eaten up by worms.

You will find the mountains of Carolina most delightful for summer. I long to have another summer there, and still dream of its mountains, wooded dells, and innumerable streams of purest water. I advise you to go up the *Kanawha*. In Kanawha Co. Virginia, the Rev. Mr. Brown finds *Sida dioica* wild! and plentiful. There is very wild scenery on that river in Virginia. I have never been there. In the spring, before you set out, let me give you something of an itinerary. I am too hurried now, to do it properly. But I would by all means have you explore the deep valley behind Table Mountain, North Carolina, and take from

thence Michaux's route to the *Black Mountain*, a route where it is now most likely Shortia came from. I think it not unlikely you may find it. Asheville, N. Car. is a fine place for head quarters—good society and ready access every way. Thence make one good trip to Balsam Mts., Devil's Court House, and Table Rock, and thence out into the northern end of Georgia. I had not time to get into Georgia, and the whole region where the three states corner has been very little explored yet. Remind me to write you again in the spring, before you set out.

I did hope to have been at work on the rest of Vol. 2 of Flora ere this, but, tho I waste no time, have not got on so far yet. I have to work at Exploring Expedition collection, as well as other things. I will do my very best. I addressed a small pamphlet to you lately, with some botanical information.

I have just (in Pl. Wright.) dedicated a fine Leguminous genus to the memory of Dr. Peter,* your former associate: there are fine specimens of it in the collection of Wright 1851, which you are to share in.

Does not Mr. Griswold† deserve generic commemoration?

Carey was to have written to you, while here, but we had not time. He is a prompt correspondent, and you will hear from him soon.

Sir Wm. Hooker, always asks after you with unabated interest. We spent much time at Kew, where I worked to great advantage.

Trusting to hear from you duly again,

Believe me to remain
Yours most faithfully
Asa Gray

* Robert Peter (1805–1894), physician and chemist, born in Cornwall, England; came to Pittsburgh, Pa., in 1817. In 1833 he became professor of chemistry in Morrison College in Lexington, Ky. He studied medicine but soon gave up practice. In 1838 he was elected to chair of chemistry and pharmacy in Transylvania University and held this position until the closing of the school in 1857.

† Henry A. Griswold, professor of mathematics, etc., in the Eclectic Institute of Lexington, Kentucky. He was intensely interested in botany and helped Dr. Short explore various regions of Kentucky for plants (see page 99).

[*John Torrey to C. W. Short*]

New York, Jany. 19th 1852.

My dear Sir—

I received today a letter from Mr. Wright, enclosing one for you, which he requested me to forward. In a P.S. to mine, dated Dec. 10,

he informs me that Major Emory had arrived at Frontera (above El Paso) and had relieved Col. Graham, who would return immediately to Washington and take with him the botanical collections of the present season. When Col. G. took Mr. W. into his party the poor botanist was in rather a hard case. The great expenses of travelling and transportation had consumed most of his funds. He accepted a place under Col. G.'s command with the understanding that he was to receive a small salary—but the Col. insisted upon having the control of the entire collections. He did not say what he intended to do with them—but I have no doubt he merely wished to secure for the Commission, the credit of first publishing the new species, and then to let Mr. Wright have the disposal of a part of the collections. The results of last year's labor, (I mean those of 1850) are now safely in Dr. Gray's hands, where I saw them in a late visit to our friend. He is publishing the new species in his "Plantae Wrightianae," a memoir now in press for the Smithsonian Contributions. He will keep them subject to Col. Graham's order—unless they should pass to the charge of Maj. Emory. You may be almost certain that a full set of them will be received for you. If they are turned over to Maj. E. I promise you a good share—for the Major will place them (as well as all the subsequent collections) in my hands. If Dr. Gray retains the charge of last year's collections, you are equally sure of the plants.

I was at Dr. Gray's when your letter to him was received, and I presume he has replied to it ere this. You have doubtless read his notice of the state of Botany in Europe, and of the doings there for two or three years past. He is now laboring assiduously at his favorite science, and has quite eclipsed his old preceptor—for I suppose you know that he was my pupil until he was able to teach me.

I am now occupied in delivering my regular Chemical Lectures in the Medical College—but I find time to devote several hours to Botany. I have sold my place at Princeton, and have taken up my quarters once more in my native city. Indeed I always felt as if I were more of a New Yorker than a country man. Our college term has been so much extended and it is so unpleasant to travel backwards & forwards in the winter, that I concluded to have my home in New York, and spend two months or so in Princeton in giving my lectures there, for I retain my professorship in the college of New Jersey. You may wish to know how we succeed in New York. Our school has about 230 students (more than usual) and the University School not so many—though they place more in their catalogue. The 3rd school (established last winter) has about 50 students.

You will be amused at receiving the other letter from me enclosed with this. It was begun long ago, as you will see by the date—and laid aside to finish but got overlaid with a heap of papers and only turned up the other day! I send it in the state in which it was left.

Pray keep in mind what I have written about the Shortia. It is probably a spring plant, and may disappear after flowering and perfecting its seed. Someone should be pretty early on the ground to find it in flower. If, however, we could get the living roots there would be no difficulty in cultivating it. Even if the plant were not found, a botanical expedition to the N. Carolina mountains would be desirable, for the botany of that region is by no means exhausted.

Yours cordially—

J. Torrey

PS. I have just received a note from Mr. J. Carey Jr. inquiring as to the composition of the material used by his father for sticking his plants to paper. It seems that he wishes to give the information to you—so I took the liberty of replying to his note by stating that I would write to you myself.

The adhesive material is a mixture of *pretty strong* common glue (the pale kind) and a solution of gum ammoniac in proof spirit. A saturated solution of the latter added to twice its bulk of glue, in the condition in which it is used by joiners. It is applied to the dried specimens in the ordinary way.

J. T.

[*John Carey to C. W. Short*]

New York
18th March, 1852.

My dear Sir,

Your valued letter of 17 Dec. reached me at Cambridge, whilst spending a month with our friend Dr. Gray. About the same time he also heard from you, and it was arranged between us that he should reply to your queries as to the best route for you to take amongst the Southern Alleghanies, as he has been there three times, & knows more of the (botanically) unexplored parts than I do, myself—Especially, he has a fancy that he knows the probable track of Michaux in which the *Shortia* may be sought, with a chance of success; and who so fit to find it as your good self? If the Dr. has not already done so, ask him to write you, on the subject, and remind him as to the name and whereabouts of

Michaux' old *guide*, whom he saw, and from whom you may learn this track, in general, if not particularly.

. . . . . .

. . . . . etc.

With many thanks for your kindness on such occasions, believe me, my dear Sir— faithfully yrs.

Jno. Carey.

[*J. H. Lundgrenl to C. W. Short*]

Charleston, S. C., May 8th, 1852.

Dear Sir,

Having to express my feelings for your liberality, I feel very much embarrassed, being, as I am, but little versed in writing English. Nevertheless, indebted to you beyond description, I must beg you to be contented with my declaration that I fully appreciate the liberality and the love to the "lovely Science" which have induced you to make me an object of your kindness. The only way I can duly acknowledge your goodness I will try to go on, viz. to use all my power in fullfilling the purpose of my journey. Being stranger to many features of American vegetation, yet I hope to be as much acquainted with the same as a collector *necessarily* must be, and I expect to be able to do something for the knowledge of the Lichens and Mosses in the interesting regions I am just going to see.—I have received here in Charleston much valuable information from Prof. L. R. Gibbes,* in whose house I live at present and from whence I intend to set out on Monday morning for Asheville, N. C., this place being, I think, the first best *headquarters* I can take in N. C. My plan is to set off from Asheville in westerly direction and, as much as possible, look out in Cherokee County, N. C., this county being, I suppose, the least explored in this state.—Of course, I intend to keep an exact account of all expences [sic] and I will try to get all necessary things as cheap as possible, but as your main object seems [to] me to be to get large collections and *fine* specimens, I think it be obvious that I cannot some times avoid expences, f. ex., if I intend to get along from one place to another by foot, I must of course send my luggage by some means, and at the same time it can happen that I must pay a man to guide myself. In any case, I will avoid all expences which are not manifestly of necessary or immediate utility for my purpose.—

Pro ceteris autem dictum volo, me liberalitatem tuam & benevolen-

tiam animo gratissimo amplecti. Fac valeas, vir esteematissime [sic], et in scientia incrementum decusque longe lateque vigeas!

Observantissimus tui servus

J. H. Lundgrenl.

* Lewis Reeve Gibbes (1810–1894), professor of mathematics in the College of Charleston for over fifty years, and a versatile naturalist of great distinction. He wrote the *Catalogue of the Fauna of South Carolina* (Appendix to M. Toumey's Geology of South Carolina, 1848), *On the Carcinological Collections of the United States* (Proc. Amer. Assoc. Adv. Sci. **3**: 167–201), in which twenty-two new species of crustacea were described, *Catalogue of the Phaenogamous Plants of Columbia, S. C.* (Columbia, 1835), as well as other articles on botany, astronomy, physics, etc.

[*Asa Gray to C. W. Short*]

Cambridge, 22' Nov., 1852.

Dear Friend

By this time you must have a second letter from me, I having, in the multiplicity of my doings, forgotten that I had written already the letter answered by your favor of the 12th inst,—just as I forgot that I had already sent you via New York a copy of *Pl. Wrightianae.*

Please to use the duplicate (for such it is) for any friend to whom it may be really useful.—Or if there be none such near you—keep it for me—as the supply of copies is small.

The Part II, which answers to the collection of plants sent, is printing. I have read a sheet or two of proofs.

The Boundary Commission being broken up, at least temporarily, Wright has accepted the post of botanist to Ringgold's* Expedition to the N. Pacific, Sandwich Islands—& N. W. Coast—to be off in January.

Yours of June last, with Fraxinus 4-angulata [quadrangulata], came duly. Since then I have from Sullivant & Cooley good *fruiting* specimens of this species.

I should like some *flowering* specimens of it next spring (by mail)

We shall yet hope to see you here, if we live.

The bit of Texan plant enclosed belongs to an *Acalypha* also gathered by Drummond, Wright, etc.—but, so far as I know not yet published or named.

In haste

Yours faithfully

A. Gray

* Cadwalader Ringgold (1802–1867), naval officer, born in Washington County, Md., was in command of the *Porpoise* in the Wilkes Exploring Expedition 1838–

1842; cruised along the antarctic continent, surveyed on the west coast of America; commanded the North Pacific surveying and exploring expedition which left Norfolk in June 1853; charted Pacific shoals and islands, and reached China in 1854.

[*Asa Gray to C. W. Short*]

Cambridge, 10th Jany., 1853.

My Dear Friend

I received to-day your favor of the 4th inst. with the check of $36.— which I put to Mr. Wright's credit.

My Memoir, which will name all the plants in the parcel you have received, is two-thirds printed; and I hope you will soon have it.

Of course, many of the plants are named in my 1st Memoir—(the coll. of 1849). Those are distributed under a different form of label, with the year on it, so that no confusion can arise. The nos. run on consecutively from one set to the other.

I am mortified at my blunder about Dr. Peter. I did not confound him with the late estimable Mr. Eaton.* But, if I rightly recollect I had the information that he was dead from Dr. Torrey.

His name occurred to me while working up the Wright plants at Hooker's, 2 years ago—so that I could not have corrected it at the time. But I rested in the information I thought I had received.—

Well, Well. The proper place to correct it in my new Plantae Wrightianae has passed by.

He seems to be dead to Botany, any way

In haste
Yours faithfully
A Gray

I think you had better give the copy of Pl. Wr. to Dr. Peter, with my regret, and humble apology for the *homicide*.

A. G.

* H. Hulbert Eaton (1809–1832), son of the well known botanist Amos Eaton of New York state. He was assistant professor of chemistry in the medical department of Transylvania University and greatly interested in natural history.

[*John Torrey to C. W. Short*]

New York, March 19th, 1853.

My Dear Sir

Your letter of the 9th crossed one from me to you, which I hope you received several days ago. The Daguerreotype of your kind face was

handed to me by Prof. Silliman's* assistant. It affords me great satisfaction to possess it. My family say it is an excellent likeness—and I have already boasted to Dr. Gray that it is far better than the one which he possesses. When I get into my new house (which I trust will be in three weeks), I hope to set apart a small room for portraits of botanists. My wife has agreed that an entire story shall be devoted to the herbarium and botanical study.

You do not inform me whether Dr. Gray has sent you the two parts of Plantae Wrightianae containing descriptions of the specimens collected by W. in Texas and New Mexico. If they have not been sent, you ought to have them. I have just inserted a mem. to that effect in a letter on my table for Dr. Gray.

I have been looking out for an advertisement respecting the next meeting of the Amer. Assoc. of Science. Circulars were sent to nearly all the members, to ascertain whether they were willing to meet in *May*,—at Cleaveland—but I have not the result. If the meeting *is* held there, I hope to go, and then to have the pleasure of seeing you *in situ*.

With high regard, remain yours
John Torrey.

* Benjamin Silliman (1779–1864), professor of chemistry and natural history at Yale and founder of the American Journal of Science, which was long known as "Silliman's Journal."

[*Asa Gray to C. W. Short*]

Cambridge, Nov. 24, 1853 (Thanksgiving)

My Dear Dr. Short

Your very kind letter of the 10th inst. reached me while I was absorbed in the preparation of a couple of public lectures, which gave me a deal of work, and I delayed replying till they should be off my hands—which is now happily effected. Now I may resume my correspondence, and first of all in value is your epistle.

You may, if you have not already done so, give to Dr. Peter, the 2nd copy of Plantae Wrightianae, pt. 2.

I meant to have been at work at the rest of Pl. Wright. ere this: but Exploring Expedition Botany has kept me back; besides lately an intimation from Maj. Emory, that he would like to have some of his Report on Boundary Commission plants in general (that dear Dr. Torrey is slowly working at) come out first,—and I am always ready to oblige.

I expected Torrey to be with me to-day, that we might among other things consider about Berlandier's* Collection. But he now writes that he cannot visit me before Christmas.

If that collection is as large as Dr. Baird† leads me to suppose, and if it comprises sets of all the plants which he sent to Geneva, and which are distributed in European herbaria, and frequently referred to—as you see in all the later volumes of DeCandolle's Prodromus—it would be a very valuable collection, at least to me—as enabling me to identify a great many species founded in Europe on these collections—while those since gathered would have many novelties. If I could at all afford it I would buy the collection,—more perhaps from its having authentic originals of species already published in Europe, than for unpublished things. I should like at least a set out of the things.—And what I proposed, viz. the publication of figures of 50 or 100 critical species, about which there may be something to be said, would be a real benefit,—and, I still think, a very proper thing for you to do—in the mode of Delessert's‡ Icones Selectae of plants published in the Prodromus of DeCandolle. (I dare say, that Berlandier was not a very honest fellow —and this might, in that view, be doing his memory too great honor. I was only thinking of the use to science.) About this, hereafter. I have written for more information about the collections. Perhaps even it may be best for me to run on to Washington and inspect them,—as a look would be worth more to me than any account any-body could give me.

About the remaining matters on which you so kindly write to me. I only wish I could verbally give you an account of the whole state of things—which my time and my tired wrist does not permit me to write about as fully as I wish to.

I dare say the *Genera Illustrata* has not yet paid back its draughts on my purse. If it has nearly so, then its continuation would not involve me much. But that is not so much the difficulty:—And as regards the *Flora* not at all so (that has and would pay its way, which is all we ask). In regard to them and the other works I am so deeply loaded down with: the great desiderata are—1. *time*—Oh, that you could give me more of that.—2. *Botanical workers.* I could supply 5 Botanists with work to do for a life-time. Now *we* have lost Carey, there is no one who is any help.—If I could ever find a trusty assistant who could do much of the half-mechanical work, it would be a great relief.—But every one I have tried is as much trouble as service.—3. *Another Draughtsman.* Sprague§ works *very* slowly—will not be driven—and has feeble health—yet is

invaluable. You will be delighted with his folio Exploring Expedition drawings. Even there he does not do *half* fast enough,—tho, to do them he has for a long while—to *drop* Forest Trees drawings—(which nevertheless I have promised Prof. Henry a volume of next summer or fall)—has to drop *Genera Illustrata*, entirely. For though I do not work as fast as I always expect and lay out to—by a great sight—yet I could bring out vol. after vol. of Genera Illustrata—and new Pl. Wrightianae, etc. etc.—if Sprague could only accomplish the drawings.

I have long been seeing it perfectly necessary to have a 2nd artist—and Torrey wants another—There is more work than 3 can do—and I have now decided to write to friends in Paris (how I miss my dear and excellent friend Adr. de Jussieu!) and see if I can import one. In this I must assume responsibility and probably make advances during the 1st year, or more—tho, I do not doubt finding plenty of occupation for him that will remunerate well, at length.

In this way I may hope to accomplish more for science. My next 10 years, if it please God that I have them here, should be my best ones, and should accomplish the greater part of the work I may hope to do. I am 43 years old this week! I can just barely get on comfortably with my salary—having no children, and my dear wife some $3000 capital accumulating interest for her future, and ultimate expectations of perhaps $8000 more, we have no anxiety on her future account—So that the doing the work incumbent on me to do as Professor—and as an American Botanist, is just the work before me—which I engage in with alacrity, and with satisfaction, and single-mindedness.

But I must for the present break off this gossip and mail my letter—Will write again soon.

You know dear Carey has *married* in England,—is very comfortable—and now has sent for his library and herbarium.

Believe me to remain with strong desire to see and know you personally

Yours very faithfully
Asa Gray

* Jean Louis Berlandier, a native of Belgium and pupil of DeCandolle of Geneva, who came to this country about 1826 and set up as an apothecary at Matamoros, Mexico. Later he made extensive collections of plants in Texas, financed by DeCandolle, M. Dunant, and other subscribers.

† Spencer Fullerton Baird (1823-1888), zoologist, born at Reading, Pa. Became professor of natural history at Dickinson College, Carlisle, Pa., in 1846; assistant secretary to Joseph Henry at the Smithsonian Institution in 1850, and succeeded him as secretary at the latter's death. He wrote several important

books on American birds. In 1871 he was made head of the U. S. Com. of Fish and Fisheries, and he was one of the earliest workers in marine biology at Woods Hole, Massachusetts.

‡ Baron Benjamin Delessert (1773–1847), a French financier and philanthropist who was associated with DeCandolle in the publication of *Icones Selectae*.

§ Isaac Sprague (1811–1895), a skillful and prolific botanical artist, was born and lived in Massachusetts. He made the fine drawings for Gray's *Genera Illustrata*, as well as many others of his works. Sprague was also interested in birds and in 1843 accompanied Audubon on his expedition to the upper Missouri to help with the drawings and sketches of birds. The herb *Spraguea* of the Sierra Nevada region was named for him by Torrey.

[*Asa Gray to C. W. Short*]

Cambridge, 24th, 1854. (*June*)

My Dear Dr. Short

These are most busy times with me, the very press of college and other work, but I must acknowledge your friendly letter of the 10th inst,—particularly as I have to-day taken a decided step about the Berlandier collections of plants.

I have never been able to go to Washington yet, to examine it; but I asked our good friend Torrey to do so, when he was there at the meeting of the Scientific Association. He wrote me that there was a great mass of specimens, tolerably good working specimens, about as good as Drummond's Texan Collections, and in good preservation so far as he examined,—that the owner wanted $500 for them, and that he thought them worth it, considering the importance of having in our herbaria the species so largely cited in the later volumes of DC. Prod., etc.—and apparently a great many besides:—thought I had best advise you to purchase them on the liberal principles of advancement of Botany which you had suggested, but felt shy of advising it himself, on account of the bad issue of his advice in respect to that Swede,—which Torrey can hardly get over. I had felt determined however, not to offer more than $400—at least until I saw for myself reason for going higher. I greatly doubt if I should advise anything more on inspection; but Torrey's report was certainly in their favor. I determined to wait until Torrey came to see me,—which was to have been early this month. But it was postponed on account of my being too much occupied, until about the 4th prox.

To-day, however, a P. S. in a letter from Prof. Baird, to whom the owner has entrusted the collections, speaks of them,—that he would like to have them disposed of before he leaves Washington for the summer, etc.

Fearing that they will deteriorate where they are, I concluded to run the risk, and have offered $400 for the collection of plants—with the mss. that relate to them,—or the use of the same,—to be boxed and shipped at the owner's expense (I to pay the freight pr. vessel to Boston).

I shall soon know if the offer is accepted. If not I will make no other at present. If accepted, and they are sent I will examine and report on the collections; and we will then consider what had best be done with them.

The 1st Vol. of Botany U. S. Exploring Expedition is now out—at least the text—about 800 pages 4to—but very open style of print. The Atlas of 100 large folio plates not yet out, Sprague not having finished the drawings. I have disposed of the greater part of my extra copies to Putnam & Co. New York, so as to recover my expenses and have some copies for foreign correspondents, etc.—The text to sell for $10—the Atlas for $15. If you care for it, encourage Putnam & Co. by ordering what is out, without waiting for the Atlas to be published.

I am now working up odds and ends—at such bits of time as I get, and making ready after Torrey's visit to set to with vigor on Pl. Wrightianae, Lindheimerianae, Fendlerianae, Flora of N. Amer. rest of vol. 2 and some Exploring Expedition Monopetalae—all together. I hope I may accomplish something.

I have pleasant letters from Hooker—and lively scientific ones from his most energetic son Dr. Hooker—a young Hercules—Kew is getting to be the great focus for Botany. Bentham, you know, has bequeathed his herbm. and library to Kew—he to have unrestrained use of it during his life—and it is already deposited, with Hooker's vast one in the King of Hanover's house close to Kew Gardens—and Bentham has removed from Herefordshire to Kew, to be near it, and some botanist from various parts of the world is there—often 2 or 3 at once, all the while.

They miss Wallich* very much. He died at the age of 68.

Good draughtsmen for Botany are indeed desiderata everywhere. Fitch in England and Rivereux in Paris (the best one living—better than Sprague as an artist, probably, but he does not put so much science into his work as I have taught Sprague to do) are the only really good professional ones. We have got two women at work with Sprague now, —they can help some—and perhaps they will soon be able—or one of them—to do something more—but it is slow training them, and not very hopeful even.

If I could draw at all—anything like what Hooker and Harvey can—I could save much time, by making sketches as I dissect & study.

Torrey giving up Princeton, I think will hereafter have quite as much time for Botany as he has had for several years. He gives up a place that paid only $700 and took him out of New York and made much travel back and forth, and takes at the Assay-office a more regular, but less worrying work—and gets $2500 for it, and has a good assistant allowed him. When he gets settled in it I trust we shall get more steady botanical work out of him.

I doubt if Carey will work much more at plants—though he will find time to enjoy his herbm. I trust. He is only about 12 years older than I am. Still he might work much at plants; except that when engaged in business, it always absorbs his powers very much.

I fully appreciate what you write about *children;* and must have badly expressed myself in my former letter if I spoke of the privation as a hardship. I am perfectly content with what a wise and good Providence *withholds* as well as what it has given, and feel the great comfort, situated as I am of the freedom from anxiety for the future, which a family must needs entail. God forbid that I should repine for a moment. Indeed I never had any occasion to in all my life. But one's wife, however convinced it is for the best, would hardly be a woman if she did not long for children.

I think I wrote you that I have bequeathed my herbarium, etc., to Harvard College, on condition of a small annuity to my wife should she survive me and need it. Without children to provide for I can, without injuring any interest or neglecting any duty, continue to build it up, and leave it as the foundation of a very important collection for North American Botany, and in such a way that I might expect it to be taken care of, and continued by my successor.

But, in this busy country there are no young botanists coming on to take our places, that I see. I long for at least one good, promising fellow to turn up, and would gladly set him at work under advantages a hundred times greater than I ever enjoyed. There is a good deal of scientific talent and taste in my present College Class,—but they will all be drawn off into other more lucrative pursuits;—and I cannot wonder at it, nor indeed wish it otherwise:—until the young man turns up who *cannot help being* a botanist.

Do you not mean to come this way again—perhaps this summer. Pray, if you do, arrange to make us a visit, of some time. I long to see you.—Ever Yours faithfully

Asa Gray.

* Nathaniel Wallich (1786–1854), a Dane by birth, and a student of East Indian plants.

[*Asa Gray to C. W. Short*]

Cambridge, July 6th, 1854.

My Dear Friend

Prof. Baird's letter, received to-day, apprises me that Lieut. Couch accedes to my offer of $400 for the Berlandier Collection of plants; and that it is being boxed up for shipment to me. A condition annexed has only now been made known to me, Dr. Torrey having omitted to mention it—though he thought he had,—viz. that as good a set as well could be should be reserved for the Smithsonian Institution.

I have informed Prof. Baird that under ordinary circumstances, I could not have offered the above sum, subject to that condition. But that, the purchase having been made with the special view of rendering the collection most subservient to the advancement of American Botany, I could recognize a propriety in the condition; and that I agreed that as fair a set as could be spared of the plants should be *presented by the purchaser** to the Smithsonian Institution:—which Institution should, I thought, in this view, pay the freight of the boxes by ship to Boston, and see insurance on $400.

I trust this will meet your approval. We will consider what had best be done with the collections. Meanwhile, I think I will not draw on you; but leave you to remit to me by mail, a check on your Philadelphia bankers for $400, payable to my order, which I will endorse over to Lieut. Couch and forward as Prof. Baird shall direct, when the collection arrives, taking his receipt for the same.

Dr. Torrey is here on a short visit,—and sends his warm regards. He will soon visit me again. When I wish you could join us,

In haste

Yours very faithfully

Asa Gray

* i.e., Dr. C. W. Short.

[*Asa Gray to C. W. Short*]

Cambridge, 25 July, 1854.

My Dear Friend,

I hasten to inform you that I have received your letter containing a check for $400, to pay for the Berlandier Collections of plants; which, on arrival of the boxes, next week, I shall endorse over to Lieut. Couch, or Profr. Baird.

Prof. Henry promptly acceded to my proposition. He pays the freight from Washington to Cambridge; and I agree that the present owner of the collection shall *present* to the Institution as fair a set of the plants as can properly be spared. From what Dr. Torrey said I suppose there will be 4 or 5 pretty full sets. But I will report on the matter, as soon as I can examine the boxes, on their arrival.

I thank you heartily for your generous proffer of the fullest set for my own herbrm. If I accept it, it is on grounds connected with the importance of my herbarium for those who are to succeed us—and I have made provision—and will more fully provide (Deo favente) for the preservation and future utility of this herbarium.

I will have a printed form of ticket; but that will cost little, and I ought to be very glad to assume the charge.

Expect to hear from me when the boxes arrive and are opened. After my reporting on them, you can best judge what disposition is to be made of the plants.

I had thought that the 14th vol. of DC. Prod. was all printed. But DeCandolle lately informed me that the printing had barely begun. It will not be issued therefore, before the close of this year.

In haste

Ever Yours faithfully

Asa Gray

[*Asa Gray to C. W. Short*]

Cambridge, 29th July, 1854.

My Dear Friend

The enclosed reached me to-day, from Dr. Stulz of Hamburg.

Of course it should not require a request that I should acknowledge your favor, enclosing the check for $400—Arriving on our Commencement day it got a little postponed; but ere this you have my acknowledgment. The check is still in my drawer, as Dr. Baird has not yet advised me as to the mode of remitting it.

The boxes have safely arrived. I have opened 2 of the largest, and have examined a number of the packages.

The specimens are poorly dried—as I knew before,—the greater part appear to be under *numbers*, I think the same that they were sent to Geneva under, and distributed in Europe.

I see as yet no dates later than 1840.

The numbers run to over 3000—and I know not how much farther, but I already see that the same plant occurs over & over under different numbers.

Of many only one or two specimens occur under each number. In other cases there are from 4 to 10. A great deal is mere rubbish, except that a specimen under a number it has been distributed by is always important, for identification, etc.—others are very fair working specimens,—though not handsome and not pressed hard enough. I shall probably find, in some one of the boxes, some memoranda, by means of which I may make sure what has been sent abroad. I will also write to Hooker, to learn how high his numbers run, and to Alph. DeCandolle for similar information.

The main thing now is to distribute as soon as possible all that is worth preserving into sets, as far as they will go.

Thus far I should judge that they will make *6 sets*, of which no. 6 may contain 1/3rd & no. 3 [may contain] ½ to 2/3rd as many as no. 1.—But if we put the same things together—tho. under different numbers, I suspect 3 or 4 sets may be made very nearly complete, and as many more of half size.—But I shall discard much trash.

There are also many specimens of *woods* numbered,—no catalogue found as yet.

This will give you some idea, so that you can consider what is to be done with them.

Will you have a full set yourself, as possible?

Any that have not gone abroad *should go*, to Herb. Hooker, DeCandolle, Paris Museum, etc.—But I know not yet how many such there are.

The Texan part of the collection is familiar to us in much better specimens, of Lindheimer, Wright, etc.

I will have a label printed for distribution. Say thus—

Yours cordially
Asa Gray

Herbarium Berlandierianum Texano—Mexicanum
No. ——

C. W. Short donavit.

[Asa Gray to C. W. Short]

Cambridge, 24th Oct. 1854.

My Dear Friend

My wrist is fatigued with overmuch writing this evening, so expect not a legible scrawl. Some collections lately in that I have to name in haste for Torrey, etc.—have interrupted my regular work, and prevented my passing an hour or so each pleasant afternoon, as I was wont, in distributing Berlandier's collections. This I have done in my barn (used for little else, as I do not keep a horse); and I hoped to have been done with it before cold weather came on. I shall, however, have to finish in the house.

I had satisfied myself that the latter part of the collection, i.e. from 3050—down to 2353, had not been sent to Europe for distribution; but that we had the whole stock. For they distributed out, with very few exceptions, into 13 sets, and of half of the species there were several from 2 to 15 specimens more.

I have found, however, one serious break in this portion—i.e. I find none from no. 2580—up to 3000—, and one or two lesser breaks occur—which perhaps some of the bundles yet to be opened will supply. After coming down to 2353, the specimens become few, i.e. from two to 6, rarely 7–9. Of these I lay none out for DeCandolle (as he is supplied to this point); but put as many as I can into the set intended for Hooker —as I feel that they will be more useful for American Botany there than anywhere else, except in my own herbarium—for which I retain a full set—whether rare or common, good, bad, or indifferent specimens.

The same species occurs over & over again, under different numbers—so that I doubt if the latter part, not distributed in Europe will add many species to the list, tho. they are generally much better specimens than the earlier ones, as well as in better preservation.

Well knowing that you do not approve of bad specimens, and feeling at the time that the greater part might turn out poorer in this respect than they do, on the whole, I decided not to put your name on the printed ticket:—as thus far your name has always been affixed to a nice and handsome specimen.

I am carrying on the distribution in such a way that, as soon as finished, I shall be able to give you a report on its extent, the mode of distributing, etc.—and not long after furnish you with names for no small part of your set.

I meant to have written to you soon after receiving Hooker's letter of Aug. 15—enclosed.

On reflection, I remembered that Hooker's herbm. did not contain numbered sets of Berlandier plants—in fact had only a few, of the character he says. I have therefore provided for him as fully as he will require or care for.

DeCandolle's letter arrived only 3 days ago—I thought you would like to see it.

We can very well supply a tolerably full suite of the undistributed part of the collection to M. Dunant and I should like to do it, if you say so.

DeCandolle (Alph.) is a much valued friend of mine—and he, as well as other Geneva Naturalists have always furthered my desires and facilitated my inquiries in the most prompt and liberal manner.

I must set about obtaining for DeCandolle the information he asks for about Berlandier.

Let me say that the collection will be quite as important and useful to me as I ever supposed it could. It supplies the authentic originals of a great many species; and the unpublished parts abound in interesting plants—many of which I have published from other collections—but a good number are still unpublished.

Of the spare sets I design one for the Royal Herbm. of Copenhagen,—whence Prof. Liebmann*—who was long in Mexico, and is now working up a very large Mexican collection, is to send me duplicates of his Mexican plants.

I have lately a parcel from Stulz, in a Hamburgh package, long on the way. It contained nothing for you. Have I not forwarded something from him since your favor of Aug. 15th—so long unanswered. I have some vague idea of the kind.

Hoping to write again soon, I remain, Dear Dr. Short

Very cordially Yours

Asa Gray

* Frederik Michael Liebmann (1813–1856), professor of botany and director of the Botanical Garden at Copenhagen. His *Chênes de l'Amérique tropicale* was published in 1869.

[*Asa Gray to C. W. Short*]

Cambridge, 17th Nov. 1854.

My Dear Friend

I have your esteemed favor of the 4th, to which I make a hurried reply.

You did not return Sir Wm. Hooker's letter—It is of little moment, however. Ere this you will have heard from [him] directly, as his last to me mentioned his having written, and also sent some publications by the hands of a friend & neighbor of yours.

You are welcome to keep DeCandolle's letter (at least till you get one from him directly, as you [he?] will be sure to write, on receiving the parcels I am to send): but I shall have to trouble you to have a copy made and sent to me, as it contains some matters about the nos. of Berlandier's plants, etc.—which it is needful I should have.

Both the weather and the pressure on my time have prevented my going on with the distribution of Berlandier's plants for some time. I hope soon to resume it, of an evening, in my study,—which will not be difficult, since the specimens of the present part of the collection are only 1, 2, 3, or 4 of each number—and those not very good ones. I think it is about to improve again further on. The *complete sets*—in considerable number are restricted, you know, to the part of the collection not formerly distributed in Europe. I am sure Mr. Dunant would not accept any part of the collection at the sacrifice of your sets,—nor does he need any except of the part not sent by Berlandier and distributed,—and of this portion there is an abundance—and I propose that a full set of them shall be sent to him.

By to-day's post I will write to DeCandolle and say this, and your perfect willingness to yield any claim in their behalf, or make up, as far as may be, for Berlandier's shabbiness.

Wright sent the real *Lucerne* (*Medicago sativa*)—I think under the name *Alfalfa*—but am not sure.—It is cultivated in N. Mexico, Sonora, etc.—also in S. America.

It is a good deal cultivated here by our gentlemen farmers, for *Green food*, for stall-fed cows, etc.

I knew Lapham* was illustrating our grasses in the manner you mention, and I have received from him a proof, which looks very well indeed.

Ever, Dear Sir,
Yours sincerely
A. Gray

* Increase Allen Lapham (1811–1875). He was born in New York but from 1836 made his home at Milwaukee, Wisconsin, doing various engineering jobs and writing on geological, botanical, and antiquarian subjects. He was an expert map maker.

[*Asa Gray to C. W. Short*]

Cambridge Feb. 5th, 1855.

My Dear Friend

Your favors of the 6th & 8th both reached me duly at Washington. And on my return home late last week, your box for Sir Wm. [Hooker] met my eyes. I was not in time to send it last week, and thought it best not to entrust it to my Express-man for shipment, lest some thing should go wrong.—But it shall go next week.

Your letter to Sir William I shall enclose in one of my own to be written this evening and dispatched via N. Y. steamer of Wednesday.

I need not say that it will always give me great pleasure to act as an intermediary in your correspondence with Hooker, or any other foreign botanist. Sir William is one of my nearest and dearest friends—now of almost 20 years standing.

I had a pleasant time at Washington—as did Mrs. Gray. I gave 9 lectures on vegetation—3 a week—to a very handsome audience—and had frequent conferences with my good friend Prof. Henry. He is well sustained by the Board of Regents, and I trust will be by all other authorities. He is not only wise and large-minded, but one of the most honest, incorruptible, and unselfish of men.

Not only all men of Science, but all good and true men should give their influence to sustain him, against malice, hatred, and falsehood.

I am clearing off a huge pile of letters, preparatory to setting to work at plants again. I have still nearly a month of vacation left.

Ever yours faithfully
Asa Gray

[*Asa Gray to C. W. Short*]

Cambridge, April 2, 1855.

My Dear Friend

I have lately taken hold and *finished* the distribution of the Berlandier plants, and have your set ready to be dispatched. As they will fill a good-sized box, I hesitate a little to forward by express—unless you so direct. Perhaps Mr. Griswold could give a good address and mode of forwarding by freight trains, saving much expense. I await your instructions.

I will have a copy made from my numbered list, which will give you the names mostly as far as the genus—and often species also,—which will afford you the aid you need. And very soon I hope to publish the

determinations &c as far as to the end of Compositae. Beyond this the numbers will be cited in the proposed continuation of my account of Tex-Mex. collections (Pl. Wright. &c &c)—which I hope to be working at again soon—parallel with rest of Flora vol. 2.

The distribution and now the arrangement and elaboration of my own set is now small labor,—but it is a useful work.

Sir Wm. Hooker lately wrote that he was to send a packet of seeds to me for you. They have not yet arrived,—probably will come a fortnight hence—

In great haste
Ever Yours most cordially
Asa Gray

[*George Engelmann to C. W. Short*]

St. Louis, April 12, 1855.

My Dear Doctor

I was delighted to see your well known handwriting again after so long an intermission. But I believe the silence was caused by me. Be it as it may you broke it in a most agreeable way by sending me that interesting collection of plants, some of them entirely new to me. My best thanks for them.

My leisure hours get more and more circumscribed, till I shall be able to break through, give up medicine and devote all my time to the "scientia amabilis." I would almost have said that I can not do anything in Botany now, had I not had Dr. [J. M.] Bigelow here who for the last four weeks studied the Cactaceae, collected by him with great zeal and perseverance in Capt [A. W.] Whipple's Railroad expedition. He had been surgeon to the Mex. Boundary Commission and had there made friend with these spiny fellows, and was well prepared for his last expedition 1853–54. He went up the Canadian and almost entirely under the 35 degree of latitude, and found there probably as many as 40 species of Cactaceae! Many of them, new.

I have come to the conviction that our western Opuntia is distinct from the eastern O. vulgaris which seems to grow only along the seacoast or at least only in the Atlantic States. I have traced our plant throughout Missouri and Arkansas and Illinois into Iowa and Wisconsin Westward it seems to be replaced by other nearly allied species. How far it spreads eastward I have no means of judging.

I can not find it mentioned in your published Catalogue but Riddell*

in his says: "sandy banks in Kentucky, & Illinois. Dr. Bigelow who lives in Lamartin Ohio has never seen it.

Elliott says there are probably 3 species in the southeastern States.

In a german work on Cactaceae I find it said that Nuttall established 3 species on plants found in *Kentucky*,

"*O. caespitosa*, prostrate, with obovate joints, very small red brown bristles and single long spines

"*O. mesacantha* prostrate, with suborbicular joints, red brown bristles and long brown single spines.

"*O. humifusa*, seems to be the same as one of the others."

I have provisionally adopted the name of *O. caespitosa* for the western *O. vulgaris*, and I found a texan plant, which seems to correspond with O. mesacantha. It has longer and more numerous bristles and dark brown stout spines.

But has really Nuttall established these species or perhaps Rafinesque and where may they be mentioned or described?†

I find the Opuntiae especially as difficult and as numerous as our Asters are.

Ever truly
Yours
G Engelmann

* John Leonard Riddell (1807–1865), physician and botanist, born in Leyden, Mass. Published *Synopsis of the Flora of the Western States* in 1835. In 1836 he became professor of chemistry in Medical College of Louisiana (now medical department of Tulane University). He compiled a catalogue of Louisiana plants, published in abridged form as *Catalogus Florae Ludovicianae* in New Orleans Med. and Surg. Journal, May, 1852. He contributed to the development of the binocular microscope.

† These are Rafinesque species, not Nuttall. Britton and Rose (*Cactaceae* **1**: 127. 1919) consider them all synonyms of *O. opuntia* (L.) Karst.

[*Asa Gray to C. W. Short*]

Cambridge, 19th April, 1855.

My Dear Friend

Our late letters crossed. Last evening I got the small box from Hooker, and to-day, since my lectures, have unpacked it,—put the 11 live plants into a small box—and packed with your Berlandier set into a large box, which goes to-morrow by Adams Express—addressed,

as you desire, to *W. Allen Richardson, Esq.* Louisville, Kentucky.—I hope it will reach you promptly, with *the live* plants (of no great consequence) *alive*, and the seeds in good time.

I meant to have looked over the small parcel of plants you sent for names—and, after naming such as I can, return to you in this box. But I have not now a moment of time—college work, garden, and an article for Silliman occupy every moment. It must wait awhile. Some, I see, must be named by Dr. Torrey.

The box from Hooker—tho' duly marked "On his Majesty's Service" by some minunderstanding, was charged freight and commissions, etc. £ 1. 0. 4.—the bill sent to me by shipper, marked "Paid in Liverpool", therefore charged back to Hooker.

By next week's steamer I shall therefore direct a friend of mine in Dublin, who acts as small banker for me and keeps a balance in his hands from me, to pay this sum to Hooker by a post-office order.

I will take from you 1/3 of this.	=	$1.67
of. charges from steamer etc.		.33
		$2.00
Sending box to Boston		.25
		$2.25

I will have the Express-man from Cambridge get a receipt from Adams & Co.—and enclose in this for the large box.

As soon as I can I will furnish you with names—as far as may be, of Berlandier's plants. They contain much rubbish, but some fair specimens and many good things. Yours truly as ever

Asa Gray

[*Alphonse DeCandolle to C. W. Short—April 25, 1855*]

Monsieur le Docteur

Permettez que je vous exprime sans intermédiaire ma reconnaissance et celle de M. Dunant, pour le cadeau que vous voulez bien autoriser le Dr. Gray à nous faire sur les plantes de Berlandier. Ce dernier est allé au Texas par les soins et aux frais de M. Dunant, de mon père et autres souscripteurs; il ne s'est pas trop bien conduit à leur égard, mais l'association a été liquidée par une perte finale et maintenant M. Dunant n'a rien a réclamer des heritiers de Berlandier, encore bien moins des personnes qui ont acheté de bonne foi des collections de lui. C'est

donc pure générosité de votre part de nous envoyer des doubles et je me fais un plaisir de vous le témoigner. M. Dunant vous aurait écrit si je ne m'etais offert pour tenir la plume et s'il n'etait en voyage depuis quelques mois pour motif de santé.

Le Dr. Gray me dit que vous aimez les autographes de botanistes. Je vous envoie ci-joints trois fragments des manuscrits de mon père et, ce qui est un peu plus difficile à trouver, sa signature complète. Il rédigeait toujours ses articles botanique sur des morceaux de papier quil fixait ensuite dans l'ordre adopté définitivement. Ceux-ci avaient été rédigés en vue du *Systema regni vegetabilis* et ont servi (en les abrégeant) à la redaction du *Prodromus*.

Je possède beaucoup de lettres et manuscrits de botanistes, mais jusqu'à present je n'ai pas en le loisir d'arranger la correspondance de mon père où se trouvent les plus intéressants. Si vous desirez des autographes vous pourriez me donner une liste des noms d'auteurs qui vous manquent et tôt ou tard, cette liste sous les yeux, je mettrais de côté ce que je trouverais dans mes papiers et dans ceux de mon père.

Agréez, Monsieur, l'assurance nouvelle de mes remerciements et de ma consideration distinguée.

Alph. deCandolle

Genève (Suisse) 25 Avril 1855.

[*Asa Gray to C. W. Short*]

Cambridge, May 2, 1855

My Dear Friend

I trust before this the box, by express, announced by my last letter has reached you—in good condition.

I have been very much occupied, in addition to College duties, &c—in writing an *Editorial* article for the July number of Silliman, on the Smithsonian Controversy—which, as we want to make it the *leader* for the July number has to be in hand early. It has been sent on to New Haven. When it appears I trust you will think it proper and seasonable.

At length, getting a little leisure, I have looked through your parcel of plants to be named, from Calif. &c &c—have named a good share of them, and put up the parcel to return to you.

I have also named and put into said parcel a few plants that you evidently wanted names for in the larger parcel intended for me. On the opposite page you will find my opinion on a few more such, of which I have retained the specimens.

Spring though late is opening pleasantly. Jeffersonia and Sanguinaria are just in blossom.

I am now going to name carefully all my Berlandier plants up to the end of Compositae and put away in Herbarium.

It is not worth while to send this parcel separately, by Express, so I will address it outside to Morton and Griswold, and leave it at Little & Brown's—to go in first case to Louisville.

By the way, you will be glad to know, that the late Mr. Brown (Little & Brown) left a legacy to purchase books on Nat. History to the amount of $5000—for our College Library—the books to be selected by the Prof. of Nat. History, i.e. by

Yours cordially
A. Gray

"Fraxinus A. & B." = F. Americana.
Euphorbia, Banks St. Lawrence = E. Helioscopia.
Coreopsis cult. for C. Drummondii, more like C. auriculata = *C. auriculata.*
Xyris, New Jersey = X. Caroliniana.
"Ceanothus azureus ? Cult. = Yes!
Cyperus Grayii? N. J. = Yes!
"Campanula, Montreal" = *C. rapunculoides.* Introduced.
"Oenothera speciosa? Texas" = O. sinuata.
Stout-umbelled, growing with Cicuta maculata. Long Branch, N. J. = *Cicuta maculata* as far as I can see.

[*Asa Gray to C. W. Short*]

Cambridge, May 21, 1855.

My Dear Friend

With your excellent ideas, and superalitively [sic] excellent practice about botanical specimens, I am not surprised that you should be grieved and indignant at Berlandier's poor stuff. But I am very glad you did not burn the plants up. Now I have more patience, being used to all sorts of rubbishy specimens. The whole collection of South Sea Exploring Expedition is scarcely any better. And there is a vast deal in Berlandier's collection which I am exceedingly glad to have, and much more that I must make room for in my herbm. in order to know to a surety what this or that number, distributed in several herbaria, is. But you are not bound to give them house room; and if they are too great eye-sores to you, don't commit them to the flames, but present

them to the herb. of the Academy of Nat. Sciences of Philadelphia. They will be very thankful for them, I know.

I see ample evidence that Berlandier was not only a lazy lout, but a great *scamp*, as you say. I find he used to collect a quantity of a plant all at one and the same time, and distribute only a part under one number—and afterward give the rest under another number—Sometimes the same stock was distributed and sold under 3 or 4 numbers!

I have determined the plants very successfully up to the earlier Leguminosae—and shall soon finish up to Composita inclusive. But just now my college work is onerous and pressing—leaving not much time for botanical investigation.

My article on the Smithsonian Institution will appear in the July number. I shall send you an extra copy.

The choice of the books on Mr. Brown's legacy was left to me on account of the name of my professorship,—tho, I teach no Natural History except Botany, including Vegetable Physiology.

I think I wrote you of the Hon. Miss Murray,* to whom I gave an introduction to you. I think by this time she has visited Louisville, and I hope you have seen her.

The *100 folio drawings* of 1st vol. Exploring Expedition Botany are all in engraver's hands at Washington. But there they get on slowly. Proofs of a large part were promised me long ago, but they do not come. They get on very slowly there.

Your check for $20 much overpaid any expense incurred by me on your account. Your next boxes or parcels for me to forward please send unpaid,—or give me any commission to execute for you—that in time I may use up the balance.

In usual—& indeed *unusual* haste,
Yours most cordially
Asa Gray

* Amelia M. Murray, who travelled in this country in 1854–55. Her published *Letters from the United States, Cuba and Canada* (G. P. Putnam and Co., 1856) express great sympathy for the South in the question of slavery.

[*George Engelmann to C. W. Short*]

St Louis, June 12, 1855.

My Dear Doctor

Your favor of May 13 has been in my hand some time; and I hope your plants have now reached Dr. Mead—I had them here some time before I could find an opportunity of sending them.

Your offer of Rafinesque's writings I thankfully accept; though I believe with you that the trouble of sifting the little good wheat from the mass of chaff is vastly greater than to go to work anew without paying any attention to him.—Agassiz however lately has paid more attention to his labors about fishes and seems to consider him quite sharp sighted, and ahead of his contemporaries. I fully agree in all you say about Nuttall—I find that implicit reliance can be placed on all he says—though his judgement may err.—I have never met with him—but have been told of his personal appearance as of great oddity—he is said to be very reserved, and unsocial.

You do me too great an honor in classing me with Carey, Sullivant and others—Though I confess that my desire would be to devote myself entirely to botany. What has become of Dr. Chapman?* He has not answered my letters since years. I do not know whether he is alive or dead, negligent only or does he not want to answer me?

How is it that in the rising generation we find no botanists—not even so far as I know, amateurs? or very few at best?

My best thanks are due you for the interesting Berlandier collection received through Prof Gray. Together with Lindheimer's, Gregg's and Wright's it goes far to complete the botany of the Rio Grande Valley.

I remain, my dear Sir
Yours faithfully
George Engelmann

* Alvin Wentworth Chapman (1809–1899), physician and botanist, was born in Massachusetts but spent most of his life in Florida. He was the author of *Flora of the Southern United States*, published in 1860 with later editions in 1883 and 1897. He furnished Torrey and Gray with many southern plants for their *Flora of North America*, and they named the genus *chapmannia* for this distinguished botanist.

[*George Ticknor to Asa Gray*]

Boston, June 18, 1855.

My dear Sir,

I have no objection whatever to permit a person, such as you describe Dr. Short to be, to have a copy of my Head of Sir Walter [Scott]; and, probably, I can give him one or two documents in relation to it, which will make him value it as a true likeness. But I am not ready to recommend any person as a suitable artist to copy it. I have inquired, and will inquire further; but as the whole value of the picture must depend on its faithfulness, I think it still more for Dr. Short's interest

than for that of anybody else, except my friend Leslie,* who painted the original, that the right person should be hit upon;—or at least a person who may be safely trusted. When it was painted thirty years ago, Leslie was anxious about this very thing, and Sir Walter desired that it might not be copied or engraved for a certain number of years,—7, I think,—lest it should interfere with artists in G. Britain, whom he was bound to favor. But that is thirty years ago, or nearly so much, and all those people, I suppose, are in their graves. I am quite free, therefore, to do as I like;—but I feel that I ought not to consent to the picture's being copied unless a suitable artist is proposed for it or I can find one. So much seems to be due to Leslie. So much, I think, your friend Dr. Short would desire.

Yrs. very truly,
Geo. Ticknor

Prof. Gray.

* Charles Robert Leslie, R. A. (1794–1859), born in London of American parents; came to Philadelphia in 1799; returned to England in 1811 but was again in America in 1833 as professor of art at West Point. In the fall of 1824 he visited Abbotsford and painted a portrait of Sir Walter Scott for Mr. Ticknor of Boston, a well known patron of arts and letters.

[*Asa Gray to C. W. Short*]

Cambridge, 21st June 1855.

My Dear Dr. Short,

I have yours of the 1st & 5th—the latter enclosing the letter for Nuttall which was duly forwarded by British mail.

When convenient, please send me some seed of the delicate *Collinsia verna*. It is long since I have seen it growing, and I have formerly tried in vain to get seeds of it.

As to yours of the 5th, about portrait of Sir Walter. What follows will explain the delay which has occurred in my reply.

As to Mr. Ticknor—a gentleman of fortune and great scholarly acquirement—predecessor of Longfellow as Prof. of Modern Languages & Literature here—author of History of Spanish Literature—etc—remember the lines

"Whom not to know argues one's self unknown."

I waited till I could go to Boston and prefer your request in person—But he was not at home when I called. So I wrote a letter to him. He evidently took some time to enquire about a painter, and his note, dated 18th, was not mailed till the 20th & reached me to-day.

I enclose it, for you to retain, if you wish.

Ames is now here, I think—perhaps the best painter—at least the best colorist—but he does not always hit likenessess.—So might not copy Sir Walter well. Mr. Ticknor would best know. If you will leave the choice in his hands—and drop a line, through me, to Mr. T. acknowledging his courtesy and commending it to his judgment, I will see him duly, and the thing shall not fail through any lack of diligence or attention on my part.

I am quite gratified to have you avail yourself of my services in all such ways.

By the way Hooker has returned my little remittance to refund the freight the steam packet company charged on his box to us,—and has blown up the said company for making a charge they had no right to (as I knew)—and for which they have begged his pardon. Hooker did not know that I was apprised of their having charged him freight. So I hold in my hands a large part of the sum I charged you—besides this balance—quite a little balance—so that I can pay little bills for you some time yet.

Did I send you a little photograph of myself—a copy on paper from a negative for which I sat for the Senior Class—as did all the Professors, etc. I can send you a copy if you wish—and also from a larger one, probably—much finer as a picture, and larger, but Mrs. Gray thinks not so good a likeness. You can have your choice—i. e. you can have both. The little one I can send in a letter, if I have not already.

With Agassiz' Circular,* I send the private one he sent me. The influential men are taking it up with spirit in Boston—and it will doubtless *go*.

If you care to subscribe send through me.

Still very busy—& this summer must be still more so, if I would do half of what I ought & *must*. Ever Yours

Asa Gray

* Prospectus of his *Contributions to the Natural History of the United States.*

[*Charles Daubeny* to Asa Gray* [?]]

Oxford, July 27th, 1855.

My dear Sir

I have been very negligent in not noticing sooner your kind present of several Botanical pamphlets—and likewise the packets of plants from Dr. Short of Kentucky which came to me through your hands.

The latter are indeed for the most part Duplicates, but nevertheless

they will in many cases take the place of those we had before as his [are] better specimens.

I do not know what class of plants would be acceptable to Dr. Short, whether British, European, or Asiatic. If I knew perhaps I might be able to send him something in return from our Duplicates, which it would give me much pleasure to do. I take the opportunity of sending you two little Pamphlets of my own, one of which, on the Fungus theory of Cholera, deserves any merit it may have from following the footsteps of your distinguished countryman Dr. Mitchell.† The other points out a line of research which perhaps may be worth following up. My method is, I am persuaded, the only certain method of detecting minute portions of phosphoric acid when existing along with other ingredients in a rock.

Have you seen Dr. Hooker's Flora Indica, or the beautiful work he has edited of Indian plants drawn by the late Mr. Cathcart? I hope if you ever visit us again you will find natural history "looking up." The University of Oxford has voted £30,000 for a new Museum and the Building is now in progress. Remember me to Professor Silliman and believe me

very truly yrs
Charles Daubeny

* Charles Giles Bridle Daubeny (1795-1867), English chemist, botanist, and geologist. From 1822-1855 he was professor of chemistry at Oxford University, and during part of the time taught botany.

† John Kearsley Mitchell (1793-1858), a Philadelphia physician who wrote *On the crytogamous origin of malarious and epidemic fevers* (Philadelphia, 1849). He was the father of the distinguished physician and author, S. Weir Mitchell.

[*George Engelmann to C. W. Short*]

St. Louis, Octob. 13, 1855.

My dear Doctor

I hope you will not think too hard of me for my neglect in acknowledging the receipt of those books of Rafinesque's. They have been in my hands for some time and I was a good deal interested in looking through them; not so much I must confess at the amount of research and knowledge displayed in them as at the barefaced impudence with which he urges his decisions and assails better men. The criticism on Nuttall's Genera is particularly rich!

The whole however is of no inconsiderable interest to me as a docu-

ment appertaining to the history of the development of the Natural Sciences in this country—and of the occasional perverseness of the human mind!!

I am well occupied with Cactaceae, and as Government is going to pay the expenses I am enabled to furnish numerous plates (mostly details).

Your Catalogues I believe do not mention Opuntia, but Riddell says: O. vulgaris on sandy banks of Kentucky River, and Rafinesque mentions Kentucky & Tennessee as localities.

Is Opuntia cultivated in your gardens? Here I see it very frequently in gardens and on windows, walls etc in old pots, boxes, tinpans etc much like Sempervivum in many european towns or villages.

But our and probably all the western plants from Kentucky to the far west (certainly Nebraska, perhaps New Mexico) differs from the the N Jersey and Virginia plant, which seems to belong to the Eastern slope exclusively and is the O. vulgaris of European Gardens. Ours has larger joints, of deeper green, larger areolae with more numerous and longer and brown bristles, and mostly numerous spines; also difference in seeds.—The leaf in the young growing plant (May and June) is also very different, much longer, slender, patulous.—Do you cultivate Cacti?

Very truly yours
G Engelmann

[*Asa Gray to C. W. Short*]

Cambridge, 13' Oct. 1855.

My Dear Friend

Received (as better than none) a short and hurried line, to inform you of my safe return day before yesterday by the S. S. Canada, and to thank you for your very kind letter to my dear wife during my absence.

I was gone only 6 weeks and a day,—had two prosperous and rather short voyages. I thank God, found young Loring* convalescent,—brought him home in very good condition. Had 11 days in Paris, a week in England. Missed dear friends I wished to see,—such as Joe Hooker—but saw and enjoyed others, among them good Sir Wm. and Bentham who came down from the country to meet me, and the venerable *R. Brown*, whom doubtless I never shall see again in the flesh.—Also saw Boott†, etc.

Sir Wm. Hooker asks much after you, and longs to see you.—(I am

to get *your photograph* for him when I can). He bears no marks of age except in whitened hair, his form is as straight and his mind and body active as ever. His portrait painted for Linn. Society is now being engraved from. He will send you a copy. I took to him the last and most wretched part of the Berlandier collection. He insists that it is *very valuable* to have.

The fact is the voyage is nothing now. (Behold how easily I have made it!) and you must run over next spring, and visit Hooker, and see *Kew Gardens*—and delight Hooker's heart.

We could not get into the steamer of 13th Oct.—so were obliged to return 2 weeks earlier than I wished. But the time is very valuable here, and I had not sufficient excuse, on Loring's part, for staying longer.

The sad, very sad thing, on my return, is to learn the death of my dear friend *Mrs. Torrey*,—a deep bereavement to Dr. Torrey, I can hardly bear to think of it,—except when we think how good she was, how ripe for heaven, beyond almost any one I knew.

My wife sends her best regards—Ever thine

A. Gray

* A brother of Dr. Gray's wife.

† Francis Boott (1792-1863), physician and botanist, was born in Boston, Mass., but spent most of his life in London. His published botanical work was to great extent on the Genus *Carex*.

[*Asa Gray to C. W. Short*]

Cambridge, Oct. 26/55.

My Dear Short,

I am very sorry to learn you have been ill, but hope to hear good news of you in rapid convalescence. You should *migrate* in summer.

As to Holton's* N. Grenada plants, a full set is to go to Hooker,—and Hooker kindly promised me that as they go into his herbarium his curator shall record the names as far and as well as he can make them out. Perhaps Bentham will help a little. This you will be glad to know if you take a set,—as I will report all the names I get to you.

My object in this hurried line is to say that I am now preparing early part of Manual, new ed. for the printer, and I should like to feel more sure about the limits of some plants. I think I told you, that, to make a good botanico-geographical line, I have concluded to take in *Kentucky* and Virginia.

Now I do not possess your Catalogue of Kentucky Plants—I have only the 4th supplement. I presume the original Catalogue, etc.—is not now to be had. I must borrow Torrey's copy.

I see Riddell cites you for *Magnolia macrophylla* and *M. cordata*† in Kentucky.

The former I should rather expect. Pray tell me if this is so, as in that case I must take them in.

Any notes that occur to you as to Kentucky plants I might overlook will oblige me much.

At present, think only of those that come in the early part of the book.

Ever Yours cordially

A. Gray

P. S.

Alph. DeCandolle has sent me a duplicate of a good lithograph of him—to be given to whom I like (Torrey is supplied)—and he mentions your name, and says he will be glad you should have it if you care for it. I will *roll* it and send by mail.

Have you the fine *mezzotint* engraving of his father?

A. G.

* Issac F. Holton (1813–1874), a physician, professor of natural science in Vermont, and author of *New Granada, Twenty Months in the Andes* (1857).

† *Magnolia cordata*, a rare species, is now known to occur only from Alabama to North Carolina.

[*Asa Gray to C. W. Short*]

Cambridge, 9' Nov. 1855.

Dear Dr. Short,

Without waiting for the arrival of the pamphlets, which you are very kind to send me and which will doubtless reach me in a day or two, I add a mem. or two called for by your favor of the 3rd inst.

Cardamine Ludoviciana. Where published as "*C. praecox*, Raf."

"Arabis hispidula = Draba muralis" [= nemorosa] Where published under former name? Surely introduced in Barrens of Ky? But a queer place for a plant nowhere else intro.—Or is it indigenous.

Leavenworthia. I have an idea that both species of Torrey are one,—and the plant has white or rose-colored petals yellow only at the base says Hatch, and so it is in the flower that has appeared from seed I raised. Did you see them yourself in blossom? Have *you* evidence of 2 species? What color petals?

*Vesicaria Shortii**. I possess a portion of the plant you gave Dr. Torrey. The characters of the species are not yet known, as to the fruit. Our specimen having only unfructified ovaries,—at least no grown pods. Have you any? And can you send one?

This is becoming the more interesting, since Lesquereux's discovery, in E. Tennessee, of *another* species; which however, is rather an *Alyssum.* I send you a small specimen. This can be no form of your plant, V. Shortii??

"Viola sororia." What is this? V. cucullata?

"Stellaria palustris. Marshes about Louisville" What is this? S. aquatica?

I will send the portrait of Alph. DeCandolle as soon as I get hold of a roller to roll it on.

I hope this will find you in more confirmed health, and free from cough. I trust the *infirmities* of age are what you need not take note of for a long while yet.

In a few days, viz. on the 18th inst. I shall reach 45,—after which—except when I forget,—I propose no longer to call myself a young man—yet I feel as young and active—and almost as ardent—as at 25.

Ever Yours cordially
Asa Gray

* Now *Lesquerella globosa* in Gray, 7th ed.

[*Asa Gray to C. W. Short*]

Cambridge, Dec 3d, 1855.

Dear Short

What is the plant we in the *Flora* have called *Hypericum rosmarinifolium* Lexington, *Short.* I have no specimen. (Could you send me a few fragments). I suspect it is H. prolificum var.

Leavenworthia. On the strength of the color of the petals I have kept them apart—the 2 species—in the Manual. I have L. Michauxii growing,—the plant kept in the greenhouse is flowering a little now. Its flowers are whitish, yet it has the foliage and the manifest style of L. aurea. After looking at all your specimens, and Torrey's, I see that the length of the style is inconstant, and L. aurea is sometimes flowered. So I fear greatly for the two species.

I have *cabbaged* a little out of your herb.—as these belong to the *Cabbage order,*—not much.

Dec. 12. Evening.

There, Dear Dr.

I have only now finished—by snatches the little parcel of nice plants you sent me in the box with Cruciferae—and report the result.

The Cruciferae I have looked over, and annotated when needed—some time ago—along with the proofs of *Manual* in that family.

I have been more pressed for time than almost ever before. I am worked to the bone—(Yet health and spirits never better)—preparing copy with one hand for Manual and reading proofs—and with the other working in haste for Torrey on Whipple's Report, &c &c—and doing lots of other things—which I have not time even to write an enumeration of.

I waited till I could send you these little notes and announce the return of your Cruciferae, before I replied to some matters in your favor of the 19th Nov. which I have kept by me till now.

Lesquereux discovered the Crucifer I sent near Nashville.—I call it *Vesicaria*? *Lesquereuxii*. He is a Swiss,—a very good man—unfortunately now very deaf—and a keen Muscologist as well as general botanist—He has long worked with our friend Sullivant, and resides at Columbus, Ohio.

Vesicaria Shortii is distinct from any thing else I know.

Dr. A. W. Chapman resides at Ap[a]lachicola, Florida, the very place for your headquarters if you go to Florida. I lately had a letter from him for a wonder. No other botanist in those parts.

Now for your favor of Dec. 6—this day received.

You are quite right in applying to me. Always apply to a busy man, too, if you want anything attended to.

Other matters as well will take me into Boston tomorrow. I will take a sheet from your Cruciferae for sample—and match it as well as I can at the paper warehouse where I deal, and send you the 2 reams by Express.

Perhaps I will have your *Cruciferae* enclosed in the same box. I will have it cut to size.—DeCandolle's portrait to go with the Cruciferae. I have not a copy now of the Providence Photograph but will send for one.

I am sorry about Holton's specimens. He had to collect and carry his plants on horseback, etc. etc.

I shall dispatch you another line, probably by the time you have fairly deciphered, or guessed at, these scrawls

Ever Yours cordially

A Gray

With thanks and best regards from Mrs. Gray

[*Elias Durand to C. W. Short*]

Mar. 25, 1856.

Prof. C. W. Short, Louisville.

Dear Sir,

I have received with great pleasure your favor dated 12th inst. Although not personnally acquainted with you, your name and beautiful botanical specimens have been long familiar to me; I am in fact the same who once used to correspond with your friend and colleague—Dr. Peter. Arrived in this country since 1816, as an exploring young botanist, my position was changed by circumstances; my purse proved too shallow to live on the scent and admiration of flowers and, instead of continuing my courtship to sweet Miss Flora, I had to closet myself in a drug store, amidst the perfumes of Assafoetida, Galbanum and Valerian, losing my health and cheerfulness.

I had a family, and this family, unlike those of father Jussieu, wanting bread and clothing, I gave up my botanical studies to attend faithfully to my professional and parental duties. As one says: Labor improbus omnia vincit, I succeeded of late in throwing off the pharmaceutical harness and to return to my first love! But it was too late—I felt rusty, decrepit, unfit, although still loving and ambitious, as you may see by my poor productions. They are not owing, believe me, to an excess of confidence, but to an excess of local pride. Since the disappearance of Schweinitz, Pickering, Nuttall from Philadelphia, I remain the only botanist of the Academy of Nat. Sciences, that has leisure and disposition to work, and I could not suffer that plants presented to our Academy should be sent out from Philadelphia, to be described elsewhere.

I am a hard working man. I have been these two years occupied, four hours a day, in arranging a North American herbarium for the Academy. I am now finishing a third paper on the polar plants collected by Dr. Kane* in his two expeditions, and will soon begin the examination of Sta. Fé plants collected by a Dr. Henry of the U. S. Army. I hope I will show improvement and the justness of the old adage "Vires acquirit eundo".

I accept with great pleasure the specimens of Oenothera you offer to me. Those collected by Mr. Pratten were very poor and incomplete—the few I had, have been left in the Academy herbarium and I have not a single one in mine. The var. of Oe. Lindleyi has proved to be a new species and I think the handsomest of all Oenotherae. It was much the

fault of our friend Gray, if I did not make it at once a new species, as it really is. Most probably I shall have to call upon your generosity for some of your new species; but at present I could not say what is wanting—it will be only when I, again, look over the herbarium I am now making for the Academy, that I shall be able to take notes. There are in it [a] great many undescribed species, especially among those collected by Maj. Leconte in the Southern States. It will be a good harvest for me, if I live.

With great respect, my dear Sir, I remain your humble servant

E. Durand

Phil. March 25th 1856

* Elisha Kent Kane (1820–1857), born in Philadelphia, naval officer, physician, explorer on route to north pole, author of *Arctic Explorations: The Second Grinnell Expedition in Search of Sir John Franklin, in the Years 1853, '54, '55* (2 vols., 1856).

[*Asa Gray to C. W. Short*]

Cambridge, Oct. 10, 1856.

My Dear Dr. Short,

I am very sorry that you should have returned to Kentucky without my having a chance to meet you: but am pleased to hear of your recovered health. You should have summered *down east* here with us.

Engelmann has been here now for a month or more, working like a good fellow, at Cacti first, now at *Euphorbia*. He will not get off for Europe before November certainly,—though he works hard, and constantly.

The likeness of dear Hooker is a flattered one, certainly,—not that he is not a very fine looking man. He is well pleased you should have it, and has supplied Greene, on the spot. By the way, Hooker is neither a Scotchman nor a Baronet. He was born in England—in Norfolk, I believe,—tho. his father was originally from the S. of England, I think, and only went to Scotland on being appointed Regius Professor at Glasgow. He had already married Dawson Turner's daughter. Before this he had made his trip to Iceland, as a young man, collected there,—was interrupted by a curious bit of a revolution there got up by a remarkable filibuster,—the ship he returned in was set on fire—and all his collections were burned up.—It is an interesting book, that of Hooker's, and I advise you to read it, if you get hold of it.

Wm. IV made him a Knight of the Hanoverian order,—which gratified

Lady Hooker. A title to transmit to descendants is more than his only surviving son, Dr. Hooker, would care for (rather despising such things) without a fortune to sustain it,—and Hooker will barely leave his family comfortable, but no fortune to make anyone independent. His son will succeed him at Kew, however, if he survives his father. Long may both flourish.

I am not surprised at what you say of Herbm. at Acad. Philad.

Would you give me leave, on my own responsibility, to sound Prof. Henry, and see whether they would like to take your herbarium on the conditions it would be best to affix, to secure it in perfect preservation. I should have cases made in a manner I could explain, with battened doors shutting always tight, etc.

If there should be any doubt about it there, and no proper and safe place offer in your own State for so valuable an herbarium, I now think I may be able to secure a proper place here. There is an old accumulating fund for building an Anatomical Museum, left by Boylston, and it is now being filled [fitted] up by subscription of a few thousand dollars—for our museum of comparative anatomy, etc. When the new building is erected the small detached building now used for the Museum, and above for Wyman* and my lecture-room, will be vacated, I am going to apply for it, and for the old cases all fitted up in it, for a Museum of Vegetable Matters and products, on the plan of Hooker's etc.—and shall probably get it. Then I must try to lay a good foundation for a Cabinet of woods, fruits, fibres, etc.—etc.—and, as the building is detached and brick, it will be the safest place for finally depositing my herbm. when I am done with it. For here at the Garden we are much too poor to get a detached fire-proof room to keep the herbarium in. And if we ever improve our small fund by subscription or any other way, it will all be wanted for the garden itself. So that, if I can secure the small building 2 or 3 years hence, I shall probably arrange to have my herbm. go down there for its final rest, and yours shall go with it as a separate herbarium, if you can make no better disposition of it. But I think the Smithsonian would take proper care of it.

I will add seeds of *Pentstemon Torreyi*.

Your Helianthus doronicoides began to flower a few weeks ago. Engelmann and I compared the plants and the tubers with *H. tuberosus*, and we are convinced they are the *same species*.—So there is an important point settled. I shall compare them again carefully another season if I live. Is the plant you sent me roots of just about the same as the doronicoides so common wild about you?

As to Nuttall, he is a truthful man, no doubt, and an interesting one. If I ever spoke disrespectfully of him (as I may have) I was to blame. His Genera was an admirable work for its day, and much the best thing he ever did. His later works and memoirs fell off in character, sound judgement, and conscientiousness—very much indeed, and there are things about them that would tempt one who followed closely after him to compare him with Rafinesque; but it would not be just. If Nuttall had kept up to the promise of *Genera N. Amer. Plants* he would have been the great expounder of American botany.

I can soon send you family or generic determinations of enough of Fendler's Venezuela collections to be of much use to you. Remind me again if I neglect it too long. A quantity are to be distributed into my herbm. first, and I have no chance to do it yet. I lately had an interesting letter from Fendler.

Manual has been out 5 or 6 weeks. I though you had got it from New York, or I should have sent you a copy. Had I not better do it now?, and send with it a copy of Sullivant's extra issue of the Mosses, large paper, proof plates—a very pretty volume, just out of the binders' hands, yesterday. Only Sullivant I suppose will insist upon sending you a copy.

Carey—incited by dear Boott, gave me some notes on Carices for new edition. Said he could do no more till the days got longer, so that he could examine plants by daylight out of business hours. He will probably not do much more in Botany, but keeps up the love.

It fortunately happens that I have no *college* duties this year at this season. But it is quite impossible to be absent from here. I am now putting a new fence round the garden—in place of one which has most of it been in wear for near 50 years! I have raised 1000 dollars by subscription to do it with,—as nothing could be spared from our income of $800 or $900 a year for that purpose—and I have to see to it and make it go as far as I can. But next fall, if we live, and I am equally lucky in the arrangement of college studies, and make such progress in work on hand that I feel I have any honest right to a holiday, I hope my wife and I may make a trip west, and come and see you. We should like it of all things. God preserve you all meanwhile. This is a long letter for me.

Ever Yours cordially
Asa Gray.

* Jeffries Wyman (1814–1874), professor of anatomy in Harvard College and first curator of the Archaeological Museum there.

[*Elias Durand to C. W. Short—Mar. 17, 1857*]

Prof. C. W. Short, Louisville, Ky.
Dear Sir,

Your favor by Prof. Richardson was received a few days ago. Urgent occupations and indisposition have prevented me from returning his visit, before his departure for Louisville, where he told me he was shortly to accompany his lady. I will be happy to cultivate Dr. R.'s acquaintance, when he returns to Philadelphia and is disengaged from the troubles attending a removal to a new abode. I hope the presence of your daughter in our city may dispose you altogether to come and settle here.

You ask me, dear sir, if I possess a suite of Berlandier's collections in Texas and Mexico? Helas! no, and I regret exceedingly not to have any. A particular friend of his had given me a letter for him, and I was ready to open a correspondence wit him, when I heard of his death. If I desire some of his duplicates, it is more with the view to fill up the valuable herbarium Boreali-Americanum of the Academy and to replace in my own what I have taken from it to enrich the Academy herbarium (not less than 1800). Of course, any specimens you can spare, from the far western regions, will be very thankfully received.

I sent you, a few days ago, a biographical notice of the late François Michaux. My materials were authentic and all obtained here. I had written to his friend, Mr. Vilmorin, to ask him some information; but, in seven pages, I could find nothing to add to my manuscript, except the dates of his birth and death; all the other details were known to me, or very inaccurate. Seeing that they knew in Paris less than we know here about him, I have sent them a translation with more ample details than I could give in a discourse.

With great respect, my dear Sir, I remain your humble servant

E. Durand
116, South 9th St.

If Prof. Peter is still in Louisville, Please remember me to him.

Philadelphia, March 17th, 1857.

[*August Fendler to Asa Gray*]

Caracas, July 16th. 1858.

Professor Asa Gray. M.D.
Dear Sir

Your kind favor of Decbr. 26th reached me in due time while passing

through the town of Victoria on a botanical excursion to a new region of the mountains.

I am very sorry to learn that you as well as Dr. Short and some of your other friends sustained such heavy losses by the disastrous bank failures and the commercial crisis of last fall. Here in Venezuela we have no banks at all, and therefore no bank failures. A new failures of commercial houses have however occurred in consequence of the above pressure.

With regard to progress of the country, political affairs and business in general, Venezuela may be said to be in a miserable condition; and people here, even the natives, acknowledge freely, that without the importations of Indian corn, beans, flour, wheat and other products from the United States, many of the inhabitants would have to die of starvation. Petty revolutions follow each other in quick succession, press the field-labourers into military service, take by force the horses and mules of the planter, prostrate agriculture and commerce, and ruin the prosperity of the country. Ever since my return from the States, two years ago, provisions have kept up at famine prices. This is the chief cause which made me leave Colonia Tovar, to try my fortune in Caracas. For since my last letter to you the price of Indian corn rose to such a height at the Colony, that people there did not sell the little barley they had, but kept it for bread instead of maize. As soon as I found that I could get no barley, I had to give up the idea of brewing beer at the Colony. I made several botanical excursions, arranged and distributed all my plants into sets, packed them in boxes ready for exportation, and made preparations to sell my little farm and to move to Caracas.

On the 6th of June I left Colonia Tovar, never perhaps to see it again. With a heavy heart I parted from the little cabin and its environs, which I had taken some trouble to improve by changing a waste place into a terraced little garden of roses, Fuchsias, plantains and apple trees. All, including some patches of potatoes, went for the sum of 66 Dollars. Such is the regard and taste for improvement in this country. The cost of transportation of my boxes and other luggage from Colonia to Caracas amounted to 40 Dollars.

The beer I had brewed at the Colony I took along to Caracas. Before I could get a house and bottles to bottle it, another fort-night passed away. The beer had remained in barrels for three months in the Colony, had been on the road exposed to the sun for two days, and then remained a fortnight more in Caracas before it could be bottled. All this it had stood very well without spoiling in the least. On the 27th of June I

opened a beer-house. At first only a few persons came to try the beer, pronounced it to be excellent, and soon the call for it was such, that in less than a fortnight all was sold. I must own, that at times I felt rather flat to see myself as a host of a beer-house surrounded by a crowd of noisy beer-drinkers. I tried however to keep up courage by the thought: that in giving to the public a wholesome, nourishing, unadulterated beverage, I might perhaps be instrumental to diminish their taste for strong liquors, such as the miserable stuff mixed with poisonous drugs, which is sold here under the name of brandy. The rapid sale of my beer spoke for itself. When all was sold people regretted they could get no more.

My expenses here are very heavy. I have to pay 20 Dollars house-rent a month, and the other current expenses for my brother and myself are very high indeed, so that without carrying the business on uninterrupted and on a large scale I can not make much headway. Barley there is none; the little I have on hand will soon be worked up, and before I can get some from the States the brewing business will be once more interrupted.

I am therefore somewhat inclined to go back to the United States, the country I love most in spite of its excessive climate. I have tasted sufficiently the charms of solitude for four years, and now I long to return once more to enlightened communities, to move within the spheres of an intelligent and enterprizing people, and to draw nearer to the broad light of civilization and learning that radiates through the *land of progress*. The balmly air, the perfume of flowers, the aspect of a tropical sky with all its host of brilliant constellations, even the stately palm and arborescent Fern are to an Americanized citizen, when in search of a prosperous home, no equivalents against the grand sight of a free people in its onward march to civilization and national greatness, as exhibited in the United States. The care for health alone keeps me yet lingering about the salubrious mountain-valleys of Venezuela.

I have hitherto delayed to send my collections of plants, because of going to the States myself. I can take better care of them than by leaving them to the tender mercies of a ship's captain.

In Decbr. last I received a letter from Mr. Thomas Moore of the Chelsea Botanic Garden in which he says: That he makes the Ferns his special study, is at present engaged in writing an Index Filicum, has quoted many of my numbers from Sir W. Hooker's Herbarium, and should like very much to possess the plants himself. He therefore wishes to buy as complete a set of ferns as possible.

I also received a letter from Dr. Engelmann, who writes that Prof. Mettenius of Leipsick wishes a most complete set of Ferns and Director Schott of Schoenbrunn dried and living Aroideae.

You will probably soon hear from me again. Please remember me kindly to Mrs. Gray and Dr. Short.

I remain

Respectfully and cordially Yours
A. Fendler.

[*Wm. Darlington to C. W. Short*]

West Chester, Penna, July 13. 1859.

My dear Sir,

Your obliging favor of the 6th inst. reached me on the 11th, and on the same evening Adams' Express brought me your *second* remittance of Specimens, for our Herbarium,—for which our Institution is deeply your debtor, and you will therefore please accept our grateful acknowledgements. The specimens are in excellent condition,—very much in the style of those with which you often favored us, in former years. I have looked over both parcels, and find in the first one *155 species*, which are *new acquisitions* to our collection; and in the last one, I find *45 new additions*,— so that, beside the *new* acquisitions (of some 200 species), there are a large number of most interesting duplicates,—many of which will serve to replace those which are less perfect, or have been preyed upon by insects.

Our Herbarium, now, contains near eight thousand species—arranged according to Endlicher's *Genera*,—and catalogued so that a visitor can see at a glance what we have; and, by means of the classification, any species named in the Catalogue can be promptly exhibited, when asked for. I commenced (a few years since) a plan of labelling the specimens on tickets large enough to contain all the *synonyms* given in the books; and it is curious to observe how well the several *specific names* often serve to describe, or indicate, the features of the plants, thus variously named, by different Authors. This mode of labelling being a pretty big job, and somewhat tedious,—I did not get more than half through with the project; and probably shall never finish it: but it is at once an interesting and useful illustration of the specimens.

I am very sensible of your good wishes, in relation to my continuance, here; but I feel that I have no claim, nor any expectation, to be indulged with as many years of active life, and clear intellect, as were vouchsafed to him whom Humboldt styled the "facile Princeps Botanicorum."

Robert Brown had *nine years* the start of me—and got a whole century ahead of all such small fry. I completed my 77 years, on the 28th day of last April. I think Sir William Hooker is about two years my junior; and I trust he may be spared, at least, to reach the age permitted to Mr. Brown. There is something very pleasant in contemplating the green old age attained by such bright ornaments of our race, as Brown, Humboldt, & Hooker.

I am very well satisfied with the Edition of my Agricultural Botany, as revised by *Mr. Thurber** (I believe he does not claim the title of *Doctor*). He is a very respectable Botanist,—and seems to be a judicious Editor. I corresponded with him, formerly,—but never met him until he called on me, about a year ago.

You are very kind—as well as complimentary—to suggest such a work, for me, as the Biography of American Botanists. If I were younger, and possessed of the requisite materials, it would afford me a great pleasure to labor in such a field. It is, however, quite out of the question, with me, now. I am not only destitute of *materials* for such a work,—but am conscious of a kind of lethargic habitude, which has overtaken me—with a strong and increasing disposition to *procrastinate* (think of *procrastination*, at 77!) every thing like a task. But I am happy to inform you, that an accomplished Lady of my acquaintance has been engaged for some time, in a work quite germain to that of which you speak; and I feel great confidence in her ability to do justice to the undertaking. The Lady is Mrs. Isabella James (neé Batchelder, of Cambridge, near Boston,) wife of Thomas P. James Esqr. of Philadelphia, long known as the efficient Secretary of the Penna. Horticultural Society, and quite an Expert—like Mr. Sullivant, of Ohio—in Bryology, or the Natural History of the Mosses. He furnished the Mosses for the last Edition of my Chester County Flora. Mrs. James has devised an elegant Tribute to the memory of the Botanists (especially those who have distinguished themselves in American Botany). She has taken the idea from the famous Palace, or Temple, erected on the banks of the Danube, in illustration, or commemoration, of the Scandinavian Mythology,—known as the Valhalla; and she proposes to intitle the work, "Flora's Valhalla". The volume is to contain a neat *Biographical Sketch* of each Botanist deemed worthy of a niche in The Temple,—illustrated, where practicable, by an engraved *Portrait*—a view of his *Birthplace*, or favorite *residence*,—a *figure of the Plant* (if any) dedicated to him,—and a *fac simile* of an *autograph Letter*. Such a memorial of the votaries of *Flora*, appropriately executed, in a handsome quarto volume, would tell the whole story,—make a beautiful

and desirable addition to a centre table, in the Parlor of every family claiming kindred with the names thus preserved,—and indeed for all persons imbued with a particle of taste for "the amiable Science,"—or animated by a becoming regard for departed Merit.

I have exhorted Mrs. James to persevere with this laudable Enterprise,—and she is now actively engaged in the work. I have furnished all the aid in my power (such as facts, dates, & autograph Letters, &c.),—and she has collected a goodly quantity of biographical material.

If the project shall find favor with a public-spirited Bookseller, and be completed (though I cannot expect to see it),—I shall rejoice in the contemplation of the anticipated achievement. If you sympathize with it, you can, no doubt, contribute valuable aid; & I am sure Mrs. J. will be thankful for it. Having now filled my paper,—most probably exhausted your patience,—I beg you to believe me ever your very sincere and oft-obliged Friend,

Wm Darlington

Dr. C. W. Short,
near Louisville,
Kentucky

* George Thurber (1821–1890), botanist and author, born in Providence, R. I., served as botanist, quartermaster, etc., on the survey of the Mexican boundary line in 1850 and for several years collected plants along the Mexican border. He taught botany and horticulture at Michigan State Agricultural College from 1859–1863, and then returned to New York and became editor of the American Agriculturist.

[*John Torrey to C. W. Short*]

New York, Jany. 19th 1860.

My dear Sir,

I have allowed too long a time to elapse before answering your letter—and yet there is scarcely a day that you are not in my thoughts. Various cares have pressed upon me, and calls (which seem important when they occur) are increasing in number—so that for several months my correspondence has been greatly interrupted.

You speak in flattering terms of the Botany of the Mexican Boundary Report; but regret (as none do more than the authors) that opportunity was not given to revise the work as it went through the press. You know how it generally is with public printing; especially that done for Congress. The lucky fellow who gets the fat job, cares for nothing but to receive his money in the shortest possible time—and so he runs the

work through with rail-road speed. Remonstrances and coaxing have but little effect. The best that can be done is to get up a copious list of errata if they will allow this, or, have some extra copies struck off for actual botanists—and make your own list of errors to accompany what you distribute.

I spoke to Mr. Thurber about the set of his plants that he promised you. He greatly regrets that for some year or more he has been obliged to work so hard on other matters to get his daily bread, that it has not been in his power to select the specimens. He hopes however, ere long, to fulfil his promise. You are aware, perhaps, that more than a year ago, he was dismissed from the Assay Office for not complying with a demand made that he thought compromised his political independence. He has very recently been asked if he would accept the place of Professor of Botany in the State Agricultural College of Michigan,—and I believe that he has conditionally assented. He is an excellent botanist, & a very good chemist. I hope he will be chosen. Did I inform you that he was engaged in preparing, under the auspices of the Smithsonian Institution, a general Catalogue of all the plants enumerated in every book & report, as growing west of Mississippi River? Exact references to each work will be given—and thus a great deal of labor will be saved to working botanists. Mr. Thurber will refer to the numbers under which the different collections have been distributed.

If you wish to know at once the names of any Wright's, Berlandier's, Fendler's, or Lindheimer's plants, and will furnish me with a list of them, I may be able to give the names of many—and Dr. Gray will aid in the matter. It will be well, when you know the family or genus, to indicate it—which will save time in looking up the plants, as most of them are distributed in our herbaria.

I have sympathised with you, my dear Sir, in the various losses you have suffered: and only hope that you may be so "exercised by them," that they shall "yeald the peaceable fruits of righteousness". Afflictions are often grievous to bear,—but we shall some day admit, that they were no more numerous nor lasting than our best interests required.

If you wish to submit your Salices to Andersson,* Dr. Gray will forward them to that zealous botanist—and then they will be named by the highest authority in the willow line. With sincere friendship,

I remain, as ever, yours,

John Torrey

C. W. Short M. D.

* Nils Johan Andersson (1821–1880), botanist of Stockholm, Sweden, who wrote *Salices boreali-americanae, a Synopsis of North American Willows*, Cambridge, 1858.

[*Asa Gray to William Short*]

Botanic Garden, Cambridge,
November 14th, 1863.

To Wm. Short, Esq.
My Dear Sir

I duly received your favor of the 3rd inst. I had already been making the needful inquiries, and I am now perfectly satisfied with the result of them. It is so long since I have been at Philadelphia that I had forgotten that they had of late years at the Academy assigned a good and spacious apartment exclusively to their herbaria, and have it well fitted for use.

I enclose to you a recent letter from my good old friend, the head of the Botanical Committee of the Academy, with whom I have privately corresponded. He writes better French than English, but his language is easily made out.

I recommend, therefore, with perfect confidence that the Family present the herbarium to the Academy of Natural Sciences, Philadelphia, to be held by that Society under the conditions prescribed in Dr. Short's will, one of which, I believe, is that the herbarium is to be preserved as a separate herbarium, i. e. not to be ever incorporated with any other herbarium, nor any other with it.

I would add also to the donation all the unassorted collections and bundles, and provide that all specimens wanted to supply the herbarium shall be selected and added to the herbarium, on paper similar to that used by Dr. Short, giving them leave to use the residue for general purposes of exchange or other useful distribution among botanists, as the Botanical Committee of the Academy shall deem most advantageous for the advancement of Botany.

Whatever paper for the herbarium is left on hand—both the *white* for species, and the *buff*, for genus covers, should go with the herbarium, where it will be wanted in incorporating the unassorted recent accessions.

Thus, I think the intentions and desires of your lamented Father will be quite as well secured as if the Smithsonian Institution had accepted the trust. The Academy at Philadelphia is one of the oldest, best-endowed, and most trusty of our institutions, and I have full confidence in its faithful performance of what it undertakes.

I wish I saw my way for the future as clearly with my own herbarium and botanical library. It is known here to those interested that I have offered to present them to our University whenever our Corporation will build a fire-proof building for their reception and make a moderate endowment for their preservation, care, and increase. Of late there are some intimations that a wealthy gentleman may build the requisite building, which will relieve a great part of my constant anxiety.

Believe me to remain, my dear Sir, with most respectful regards to your Mother and to the other members of your family known to me by correspondence

Faithfully yours

Asa Gray

P. S. In the future peaceful times for which we hope and pray, I trust my wife and I may be spared, and may be able, to visit the Western States, where we have many friends, among which those at Hayfield,* whom we have never yet seen, shall not be forgotten.

A. G.

* Name of Dr. Short's home place, now in the city of Louisville.

[*Elias Durand to William Short*]

Philadelphia, Febr. 24th, [18]64.

Wm. Short, Esqre.
Louisville.

Dear Sir,

Your revered father's herbarium has arrived safely, and has been received by our Members with enthusiastic demonstrations of admiration for its magnificence, and of gratitude towards your family for the generous gift. It is indeed the most splendid herbarium to be seen any where, for the good preservation and beauty of its specimens and for the admirable neatness and elegance of its arrangements.

I am now taking an inventory of the contents of each volume, to enable me to make up an index or key to the orders and genera contained in them *ad usum studentium*. The loose packages, some of which had not as yet been opened by your dear father, and contain undoubtedly many new species, will be gradually incorporated with the main herbarium which will have, in our botanical room, the place of honor which it so well deserves.

I can assure you, my dear Sir, with our friend Prof. Gray, that the Phil. Academy of Natural Sciences is the right place for depositing this treasure which has cost so much labor and given so many causes of enjoyment to your dear father; It will be appreciated and carefully preserved.

The package addressed to Mr. Bebb* of Washington has been sent to him. That to Mr. Eaton will be sent to him when I know his direction. As to Dr. Boott's, I am going to write to Dr. Gray to know what I shall do with it. Dr. Boott died in London about two months ago and has, I believe, a brother in Boston.

Believe me, my Dear Sir,
Very respectfully yours
E. Durand

*Michael S. Bebb (1833–1895), born in Ohio. During the Civil War he had a position in the Pension Bureau in Washington. Later he moved to northern Illinois and resumed his botanical work, especially on willows, on which he was an authority. He wrote the section on willows in the sixth edition of Gray's *Manual*. *Salix Bebbiana* was named for him by Sargent.

[*Asa Gray to a daughter of C. W. Short*]

Herbarium of Harvard University,
Botanic Garden, Cambridge, Mass.
August 5, 1879.

Hon. & Dear Madam

I respond at once to your letter of Aug. 1, and send you the announcement in Silliman's Journal, on which (& on a later) notice, the article in the Garden must have been founded.

Year after year have I hunted for that plant! and I grew sorrowful at having named after Dr. Short a plant that nobody could find.

So conspicuous for its absence had this rarity become, that friends of ours, botanizing in the mountains two years ago, were accosted with the question—"Found Shortia yet?" from people who had seen our anxious search for it. After all, the rediscovery was accidental, and by one not a botanist. Few botanical events have excited more interest at home and abroad; and your honored father is commemorated by perhaps the most interesting flower in N. America, with a counter-part in Japan.

Well, my wife and I, with three other botanists, passed the month of

June, 1, in a visit to the discovered locality—a small patch, at the foot of the mountains, and in a diligent search for more—as it no doubt belongs higher up in the mountains.* We *did not find more of it.* But I am not yet 69 years old, and I hope to try once more, having now narrowed the region in which the search should be made with some confidence.

But we had a delightful journey.

When your memorial is printed, please let me have a copy of it. Consider that I have an interest in the subject of it, next to his own descendants.

Excuse hurried line from a very busy man, & poor writer, and believe me to be always Yours very sincerely

Asa Gray

I have had more or less to do with the naming (beside the genus) of several species for Dr. Short.

Among them

Carex Shortii

Vesicaria Shortii [now *Lesquerella globosa* in Gray, 7th ed.]

Aster Shortii

Solidago Shortii.

A. G.

The flowering specimens are left in the hands of Mr. Hyams who is a plant dealer—Statesville, N. Car. They have been gathered scantily, not to endanger the stock. Next year you shall have a dried specimen, or better, a plant, to flower for yourself. A pretty, but modest thing.

A. G.

University of North Carolina,
Chapel Hill, N. C.

* Gray was wrong in this. He was misled by Michaux's label in the Paris Museum which said "hautes montagnes." All other stations since discovered are at lower altitudes.

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